DOE/RL-2011-47
Revision 0

Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

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APPROVED
By Shauna Adams at 2:58 pm, Jul 01, 2013

Release Approval Date

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DOE/RL-2011-47, Rev. 0
July 2013

U.S. Department of Energy,
Richland Operations Office
U.S. Environmental Protection Agency
Washington State Department of Ecology

Public Comment Period
July 15 through
August 14, 2013

How You Can Participate:

Read this Proposed Plan and review documents in the Administrative Record.

Comment on this Proposed Plan by mail or e-mail on or before August 14, 2013.

Kim Ballinger
U.S. Department of Energy,
Richland Operations Office
P.O. Box 550, A7-75
Richland, WA 99352
E-mail: 300AreaPP@rl.gov

See page 66 for more information about public involvement and contact information.

Inside this Plan

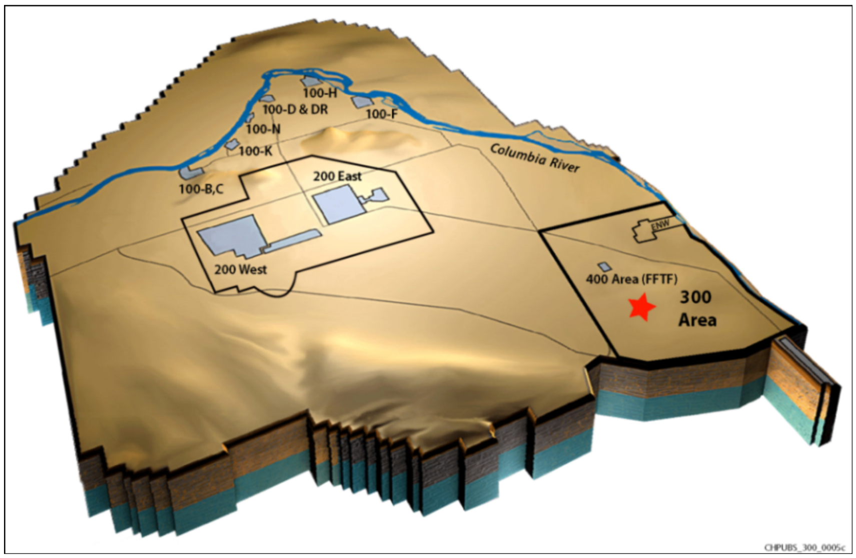


Figure 1. Location of Hanford Site 300 Area

Introduction

The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) invite the public and Tribal Nations to comment on this ***Proposed Plan***[1] for cleanup of contaminated soil in two soil ***operable units (OUs)*** and one groundwater OU in the 300 Area of the Hanford Site located near Richland, Washington (Figure 1). DOE has completed its investigation of ***waste sites***, many of which have already been remediated, and of the groundwater through the ***remedial investigation (RI)***/***feasibility study (FS)*** process. The RI/FS concluded that many of the previously remediated waste sites require no additional action, whereas other waste sites and some contaminants in the groundwater require ***remedial action*** due to unacceptable risk to human health and the environment. This Proposed Plan addresses the contaminated soil in 3 waste sites in the 300-FF-1 OU and 127 waste sites in the 300-FF-2 OU, as well as the contaminated ***groundwater*** in the

[1] Important technical and administrative terms are used throughout this Proposed Plan. When these terms are first used, they appear in ***bold italics***. Explanations of these terms are provided in the Glossary at the end of this Proposed Plan.

300-FF-5 OU, which together comprise the 300 Area ***National Priorities List (NPL)*** site. DOE is issuing this Proposed Plan to summarize and seek public and Tribal Nations input on the cleanup alternatives considered and on the ***preferred alternative*** proposed for implementation.

This Proposed Plan evaluates several ***remedial alternatives***. With the exception of Alternative 1 (No Action), all of the alternatives have the same actions for soil remediation of waste sites, which are consistent with the previous 300 Area ***Records of Decision (RODs)***. The only differences between remedial alternatives presented in this Proposed Plan are regarding how to address the remaining active source of uranium in the deep soils that are periodically rewetted by high river stage. This rewetting of the uranium in deep soils results in persistent uranium contamination in the groundwater.

Public and Tribal Nations input on this Proposed Plan will help DOE and EPA select a remedy for cleanup of contamination in the 300 Area. Following consideration of public and Tribal Nations input on the preferred alternative or other alternatives presented in this Proposed Plan, a ROD will be issued by DOE and EPA identifying the final alternative selected for implementation.

Tribal Nation and Public Involvement

Input from Tribal Nations and the public on this Proposed Plan will be considered during selection of the final remedy. Comments on the Proposed Plan will be accepted during the 30-day comment period (see sidebar on left of page 1). A public meeting will be held. For additional information regarding how to participate, see the "Community Participation" section of this Proposed Plan.

The *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (DOE/RL-2010-99; hereafter called the 300 Area RI/FS report), the *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units, Addendum* (DOE/RL-2010-99-ADD1; hereafter called the 300 Area RI/FS report addendum), and other supporting information used to evaluate alternatives and develop the preferred alternative are contained in the ***Administrative Record*** files for the 300-FF-1, 300-FF-2 and 300-FF-5 OUs, which may be viewed online at http://www2.hanford.gov/arpir/ and at the various information repositories identified in the "Community Participation" section of this Proposed Plan.

After all input submitted during the 30-day comment period has been reviewed and considered, a ROD will be issued that identifies the remedy selected. This input could result in the selection of a final remedial action that differs from the preferred alternative. A summary of significant comments received and the responses will be published in the ***responsiveness summary*** issued with the ROD, which is scheduled for completion later in 2013.

Agencies Role

DOE is the lead agency and the party responsible for conducting the selected remedy. DOE is issuing this Proposed Plan as part of the public participation requirements under Section 117 (a) of the ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*** (commonly known as "Superfund") and Section 300.430(f)(2) of the "***National Oil and Hazardous Substances Pollution Contingency Plan"*** (commonly known as the "National Contingency Plan," or NCP) (40 ***Code of Federal Regulations [CFR]*** 300). CERCLA establishes the broad federal authority for conducting cleanup at Superfund sites, and the NCP includes the requirements and expectations for cleanup.

In 1989, the Hanford Site's 300 Area was placed on the CERCLA NPL (40 CFR 300, Appendix B). Also in 1989, DOE entered into the *Hanford Federal Facility Agreement and Consent Order* ***(Tri-Party Agreement)*** (Ecology et al., 1989), which governs cleanup of the Hanford Site. To facilitate the implementation of the Site's CERCLA cleanup, the ***Tri-Parties*** (DOE, EPA, and the Washington State Department of Ecology [Ecology]) divided the overall cleanup into OUs, which are discrete actions that comprise an incremental step toward comprehensively addressing site problems.

EPA is the lead regulatory agency for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs, and Ecology is the non-lead regulatory agency and provides input to EPA on cleanup decisions. Ecology will determine if they concur with the preferred alternative after the comment period on this Proposed Plan.

Overview of the 300 Area

The Hanford Site is a 1,517 km^2 (586 mi^2) federally owned property located within the semiarid, shrub-steppe Pasco Basin of the Columbia Plateau in south-central Washington State. Historical nuclear materials production and processing at Hanford released contamination to the environment, resulting in areas of contaminated soil and groundwater that pose a risk to human health and the environment (HHE). To facilitate cleanup, the Hanford Site has been divided into three areas: River Corridor, Central Plateau Outer Area, and Central Plateau Inner Area.

The area of the Hanford Site that borders the Columbia River is referred to as the River Corridor (Figure 2). The River Corridor, which spans approximately 570 km^2 (220 mi^2), has been divided into six geographic areas. These six areas were selected to define manageable portions of the River Corridor that align with historical operations (e.g., uranium fuel rod preparation or reactor operations).

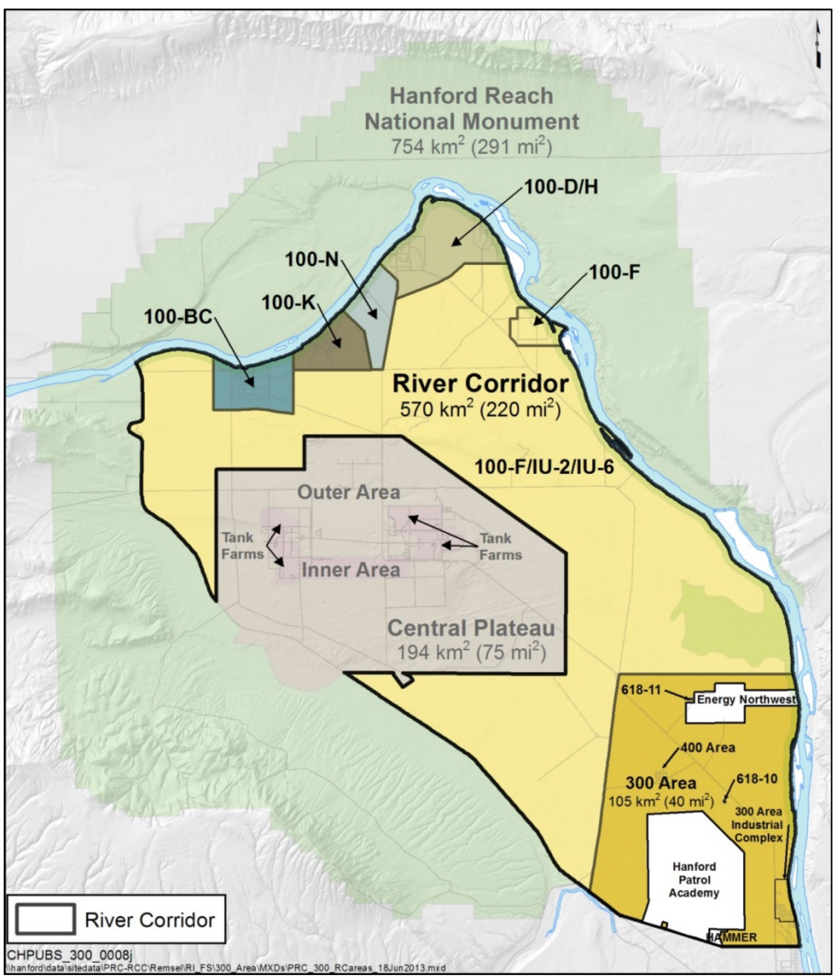


Figure 2. Hanford Site River Corridor

The 300 Area covers 105 km^2 (40 mi^2) and includes two ***vadose zone*** OUs (300-FF-1 and 300-FF-2) and one groundwater OU (300-FF-5). In the 300 Area's core industrial complex, uranium fuel rods were produced and much of the research and development for the Hanford Site occurred. The 300-FF-1 OU waste sites include primarily the large liquid disposal areas within the core industrial complex. The 300-FF-2 OU waste sites include the remainder of the waste sites within and outside of the core industrial complex. The 300-FF-5 OU includes the contaminated groundwater associated with releases from the 300 Area. With the exception of currently active areas (i.e., Volpentest Hazardous Materials Management and Emergency Response Training and Education Center [HAMMER]), Hanford Patrol Academy, and Energy Northwest), the entire 300 Area was evaluated for releases of chemicals and ***radionuclides***. The process is described in the 300 Area RI/FS report (Appendix L of DOE/RL-2010-99).

Contamination within the 300-FF-1 OU was associated with 39 waste sites in the original 300-FF-1 OU ROD (EPA/ROD/R10-96/143, *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington*). The 300 Area RI/FS associated with this Proposed Plan evaluated all 39 waste sites and is proposing additional remedial action for three waste sites to protect groundwater from uranium contamination moving downward from the overlying soil. Implementation of this additional action requires an amendment to the original 300-FF-1 OU ROD.

Contamination within the 300-FF-2 OU was associated with 127 waste sites in the 300-FF-2 OU interim action ROD (EPA/ROD/R10-01/119, *EPA Superfund Record of Decision: Hanford 300-Area, Benton County, Washington*). This Proposed Plan presents a preferred alternative and the other alternatives that were considered for the final remedy for all 127 waste sites. Once the final remedy is selected, it will be incorporated into a final action ROD that will replace the interim action ROD. The waste sites remediated under the interim action ROD (90 waste sites) were re-evaluated in the 300 Area RI/FS and are included in this Proposed Plan.

Groundwater in the 300-FF-5 OU is contaminated with uranium, tritium, nitrate, gross alpha, trichloroethene (TCE), and cis-1,2-dichloroethene. The interim action ROD (EPA/ROD/R10-96/143) identified that uranium in the groundwater would attenuate to cleanup levels within a relatively short time, which has not occurred at the rates anticipated. The 300 Area RI/FS re-evaluated the groundwater contamination and potential remedial actions. This Proposed Plan identifies several alternatives for remediating the groundwater in the 300 Area and presents the preferred alternative.

Preferred Alternative

Based on the results of the detailed and comparative evaluation, the preferred ***remedial alternative*** is as follows:

- *Alternative 3a — Removal, Treatment, and Disposal at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and Periodically Rewetted Zone; Monitored Natural Attenuation; Groundwater Monitoring; and Institutional Controls.* ***Removal, treatment, and disposal (RTD)*** is used to excavate contaminated soil from waste sites;[2] enhanced attenuation in a 1 ha (3 ac) area using ***uranium sequestration*** to immobilize the deep uranium contamination in the vadose zone and ***periodically rewetted***

[2] The RTD component of *EPA Superfund Record of Decision: Hanford 300-Area, Benton County, Washington*, the 300-FF-2 OU interim action ROD (EPA/ROD/R10-01/119), is proposed to be replaced by the RTD component in Alternatives 2 through 5. Like the RTD component of the 300-FF-2 OU interim action ROD, the RTD component in Alternatives 2 through 5 includes the following: RTD the soil as deep as 4.6 m (15 ft) in waste sites to protect human health and ecological receptors from direct exposure to contaminants; remove the engineered structures (e.g., burial ground trenches); RTD the soil both above and below 4.6 m (15 ft) in waste sites to protect groundwater quality and Columbia River water quality (or meet soil contamination concentrations demonstrated to be protective based on site conditions); and backfill the excavated waste sites and control subsequent infiltration for some sites.

zone (PRZ) that is the highest source of contamination in groundwater; ***monitored natural attenuation (MNA)*** is used for tritium, TCE, and cis-1,2-dichloroethene in groundwater; and uranium, gross alpha, and nitrate in the groundwater are monitored. ***Institutional controls (ICs)*** are used to control access to residual contaminants in soil and groundwater as long as they exceed the cleanup levels as established in the ROD associated with this Proposed Plan.

This alternative meets the statutory requirements under CERCLA and the NCP (40 CFR 300) to select remedies that are protective of HHE, comply with ***applicable or relevant and appropriate requirements (ARARs)*** (unless a statutory waiver is justified), are cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Alternative 3a is preferred because it provides the best balance of tradeoffs among the alternatives with respect to the balancing criteria specified in the NCP. The alternative also satisfies the statutory preference for remedies that employ, as a principal element, treatment that permanently and significantly reduces the toxicity, mobility, or volume (TMV) of hazardous substances, pollutants, and contaminants.

In addition to the preferred alternative, five other alternatives were evaluated in the 300 Area RI/FS report (Section 10.2 of DOE/RL-2010-99) and the 300 Area RI/FS report addendum (Section 7.1 of DOE/RL-2010-99-ADD1). Each alternative includes a combination of actions, all of which are explained briefly in this Proposed Plan and more fully in the 300 Area RI/FS report (Section 9.2 of DOE/RL-2010-99) and the 300 Area RI/FS report addendum (Section 6.1 of DOE/RL-2010-99-ADD1).

National Environmental Policy Act Values

DOE policy calls for ***National Environmental Policy Act of 1969*** (NEPA) values to be incorporated into DOE's CERCLA documentation (DOE O 451.1B, Chg. 3, *National Environmental Policy Act Compliance Program*). NEPA values include (but are not limited to) consideration of the cumulative, ecological, cultural, historical, and socioeconomic impacts of the proposed remedial action alternative. NEPA values were incorporated into the FSs. For the remedies evaluated in this Proposed Plan, environmental impacts include temporary short-term disturbance (e.g., increased traffic, noise levels, and fugitive dust) of approximately 3.1 km^2 (1.2 mi^2) for a disturbed industrial area that has low to marginal habitat quality. DOE expects minimal (if any) long-term impacts to air quality, natural resources, and historical resources; transportation; socioeconomic values; or environmental justice.

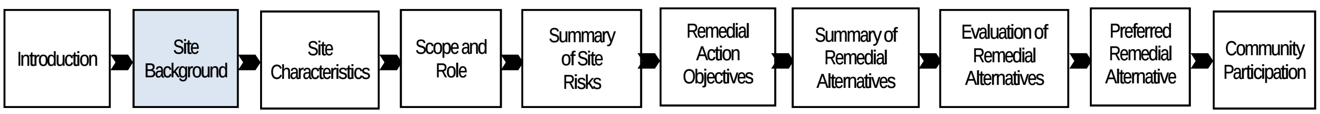
Proposed Plan Organization

The subsequent sections of this Proposed Plan are as follows:

- **Site Background:** Facts about the site contamination, investigations, previous remedial actions, and previous public participation.
- **Site Characteristics:** Description of land and groundwater use, physical features impacting remedy selection, and nature and extent of the waste site and groundwater contamination.
- **Scope and Role:** Description of how the waste site and groundwater remedial actions fit into the overall Hanford Site cleanup strategy; description of prior and planned cleanup actions.
- **Summary of Site Risks:** Identification of ***contaminants of concern (COCs)***; a summary of the results of the ***baseline risk assessment*** and land and groundwater use assumptions.
- ***Remedial Action Objectives (RAOs)*:** Description of what the proposed site cleanup is expected to accomplish.

- **Summary of Remedial Alternatives:** Identification of options for attaining the identified RAOs.
- **Evaluation of Remedial Alternatives:** Comparison of the alternatives using CERCLA criteria.
- **Preferred Remedial Alternative:** Explanation of rationale for selecting the preferred alternative and affirmation that it is expected to fulfill statutory and regulatory requirements.
- **Community Participation:** Information on how the Tribal Nations and public can provide input to the remedy selection process.

The following graphic is included before each new section to indicate where the new section fits within this Proposed Plan:



Site Background

The 300 Area encompasses approximately 105 km^2 (40 mi^2) adjacent to the Columbia River in the southern portion of the Hanford Site. This section of the Columbia River is within the Hanford Reach, a nontidal, free-flowing section of the Columbia River in Washington State. The Hanford Reach extends from the Priest Rapids Dam, downstream to the slack waters of Lake Wallula, which was created by McNary Dam. In 2000, a Presidential proclamation (*Hanford Reach National Monument* [Clinton, 2000]), under authority of the *American Antiquities Act of 1906*, set aside more than half of the Hanford Site for preservation as the Hanford Reach National Monument (HRNM), including land along the River Corridor within an average of one-quarter mile of the river. The HRNM extends into the northern half of the 300 Area (Figure 2), but there are no waste sites in this area.

Operations in the 300 Area Industrial Complex (Figure 3) began in 1943. The complex includes the buildings, facilities, and process units where the majority of uranium fuel production and research and development activities took place.

The 300 Area includes the 300 Area Industrial Complex (major liquid waste disposal sites and solid waste burial grounds) and waste sites associated with the Fast Flux Test Facility (FFTF) (the 400 Area) and the 600 Area (618-11 Burial Ground, 618-10 Burial Ground/316-4 ***Crib***, and waste sites in the vicinity east of the 300 Area Industrial Complex) (Figure 3). The 400 Area is located approximately 8 km (5 mi) northwest of the 300 Area Industrial Complex and about 6 km (4 mi) west of the Columbia River.

The 300-FF-1 OU contains waste sites within the 300 Area Industrial Complex; the major liquid waste disposal sites are the former South Process Pond (316-1), North Process Pond (316-2), and 300 Area Process Trenches (316-5), where large volumes of liquid waste containing uranium were discharged (Figure 4). The 300-FF-2 OU contains waste sites within and near the 300 Area Industrial Complex, the 400 Area, and the 618-10 and 618-11 Burial Grounds.

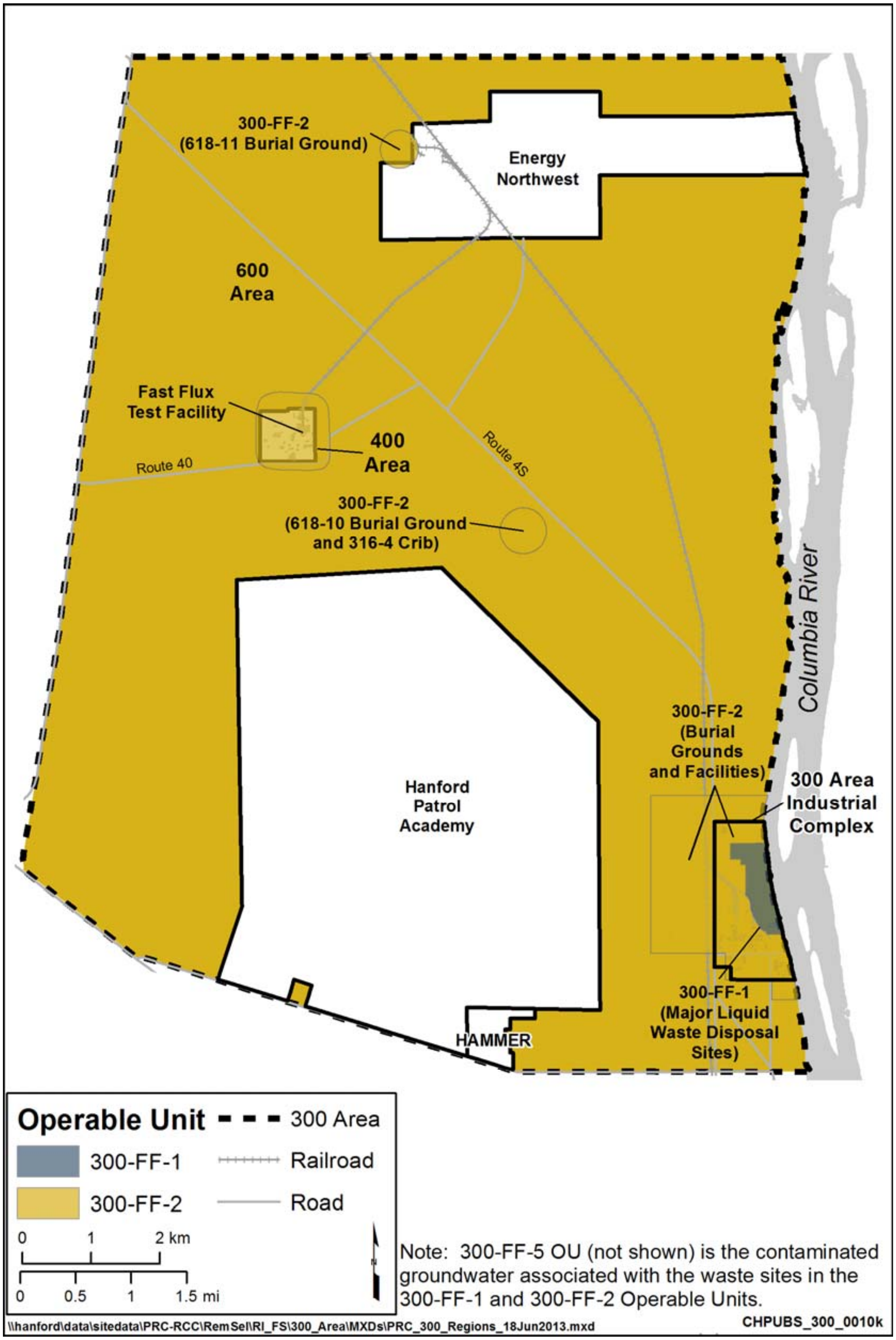


Figure 3. Hanford Site 300 Area

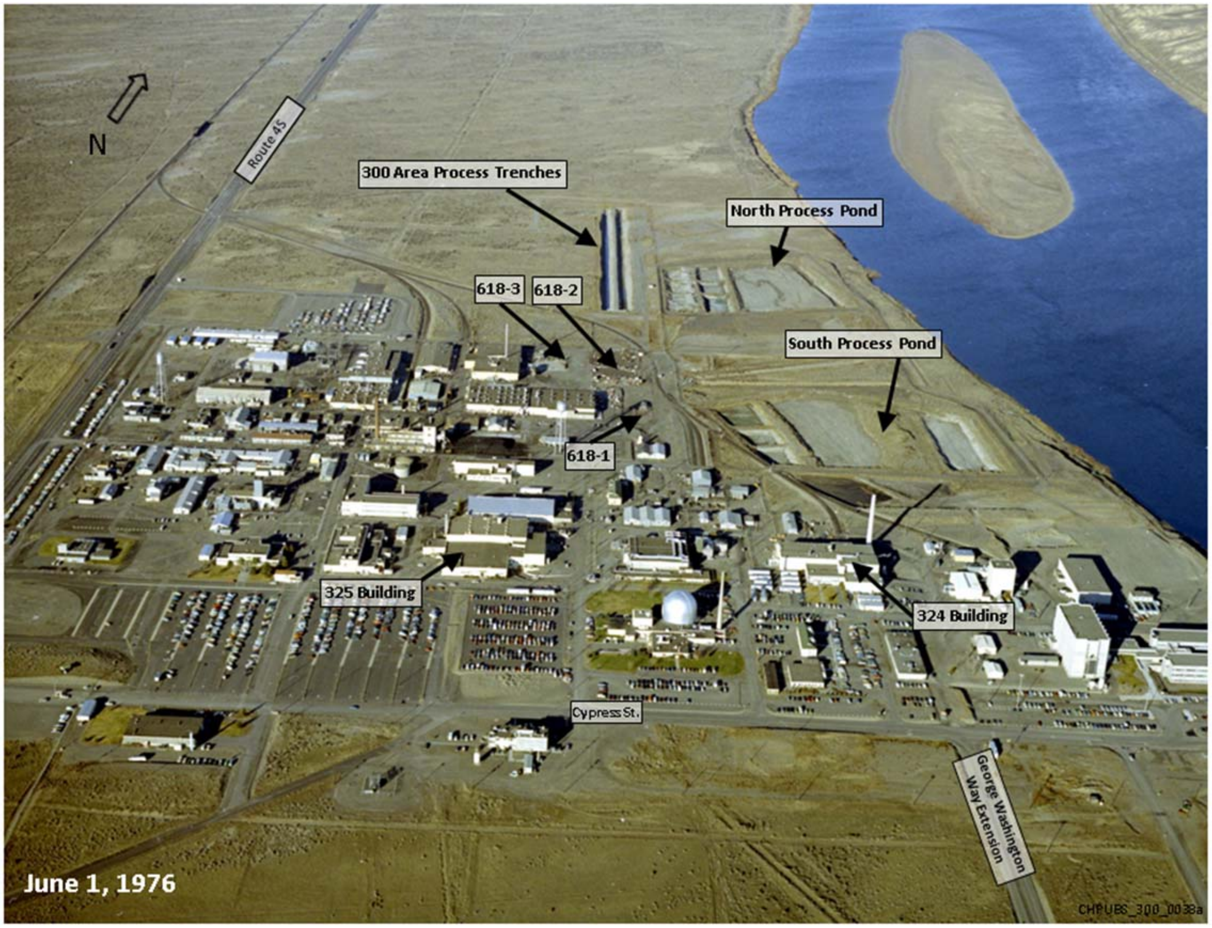


Figure 4. 300 Area Industrial Complex (June 1976)

Liquid wastes consisting of sanitary waste and various radiochemical and radio-metallurgical process wastes were discharged via the process sewer system (300-15) to open ponds and trenches during most of the 300 Area's operational history. The process sewer system consists of 50 km (31 mi) of underground piping. Liquid wastes were conveyed by the process sewer system to the South and North Process Ponds (316-1 and 316-2, respectively) between 1943 and 1975. Both ponds received from 1.5 to 11.4 million L/day (0.4 to 3 million gal/day) until they were phased out of service in 1974 and 1975. The 300 Area Process Trenches (316-5) replaced the ponds in 1975 and were used for disposal until 1994.

The primary waste stream disposed to these ponds and trenches was process waste from nuclear fuel fabrication. These sites also received radioactive liquid waste, sewage, laboratory waste, and coal power plant waste. The waste from nuclear fuel fabrication included basic sodium aluminate solutions and acidic copper/uranyl nitrate solutions. Primary chemical contaminants disposed to the South and North Process Ponds included uranium (33,565 to 58,967 kg), copper (241,311 kg), fluoride (117,026 kg), aluminum (113,398 kg), nitrate (2,060,670 kg), and large volumes of nitric acid and base (NaOH). Information on the liquid waste sites is provided in the 300 Area RI/FS report (Sections 1.3 and 4.8 and Appendix B of DOE/RL-2010-99). Disposal of these waste streams resulted in both soil and groundwater contamination.

Solid waste was disposed in burial grounds and shallow landfills from 1943 through the 1950s. In later years, highly radioactive wastes, including wastes with ***transuranic (TRU)*** contaminants, were disposed in the 600 Area burial grounds. The primary burial grounds are 300-7, 300-9, 300-10, 618-1, 618-2, 618-3, 618-4, 618-5, 618-7, 618-8, 618-9, 618-10, 618-11, 618-12, and 618-13. Detailed descriptions of these burial grounds are provided in the 300 Area RI/FS report (Section 1.3 and Appendix B of DOE/RL-2010-99).

Industrial activities associated with operations in the 400 Area also resulted in soil contamination in the 300-FF-2 OU.

Contaminant releases identified at waste sites resulted in several groundwater contaminant plumes that lie within the 300-FF-5 Groundwater OU. In addition, groundwater contaminated from operations in the 200 East Area (200-PO-1 OU) also extends beneath the 300 Area (Figure 5). Contamination originating from the 200 Areas will be remediated via a future CERCLA decision for the 200-PO-1 OU. Nitrate contamination in the southeast portion of the 300 Area originates from a source offsite from the Hanford Site.

Investigations

DOE performed RIs and ***limited field investigations (LFIs)*** beginning in the early 1990s for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs to characterize the ***nature and extent of contamination*** in the vadose zone and groundwater. DOE also completed a focused RI/FS for the 300-FF-5 OU to provide ***characterization*** of the uranium contamination and conducted laboratory-scale and field-scale pilot testing to evaluate uranium sequestration with phosphate as a remedial alternative for uranium in groundwater. These investigations collected data necessary to adequately characterize the site for the purpose of developing and evaluating effective remedial alternatives. The results of the RIs, LFIs, and focused RI/FS are described in the 300 Area RI/FS report (Chapter 2 and Appendix N of DOE/RL-2010-99).

Uranium Sequestration Pilot Testing

DOE performed laboratory-scale and field-scale treatability studies at the 300 Area Industrial Complex to evaluate the use of phosphate to sequester (immobilize) uranium as a remedial technology. The purpose of the studies was to evaluate direct sequestration of dissolved uranium in groundwater by injecting phosphate into the aquifer, and to demonstrate surface infiltration of phosphate to immobilize uranium in the vadose zone to mitigate further uranium leaching to the aquifer.

A phosphate injection pilot study (PNNL-18529, *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report*) was conducted to optimize phosphate formulations in the laboratory and to evaluate the effectiveness of phosphate in sequestering uranium in the aquifer by two methods: (1) direct formation of the insoluble uranium mineral ***autunite*** [$Ca(UO_2)_2(PO_4)_2 \cdot nH_2O$], by introducing an orthophosphate/polyphosphate mixture in the aquifer; and (2) formation of the mineral ***apatite*** [$Ca_5(PO_4)_3(OH)$], onto which uranium sorbs, by adding calcium citrate-sodium phosphate in the aquifer. The results of the pilot study demonstrated that direct injection of phosphate can achieve treatment of uranium through the direct formation of autunite. Uranium concentrations within 23 m (75 ft) of the pilot study injection well decreased below the ***drinking water standard (DWS)*** from autunite formation.

Preliminary infiltration testing has also been conducted at 300-FF-1 OU wastes sites in the 300 Area Industrial Complex. The results of preliminary infiltration testing indicated that in certain areas of the 300 Area Industrial Complex, infiltration rates may be limited. However, only a very small area was tested, which may not have been representative of the majority of the 300 Area. Infiltration rates around the former process ponds are expected to be high, as demonstrated during past liquid waste discharges.

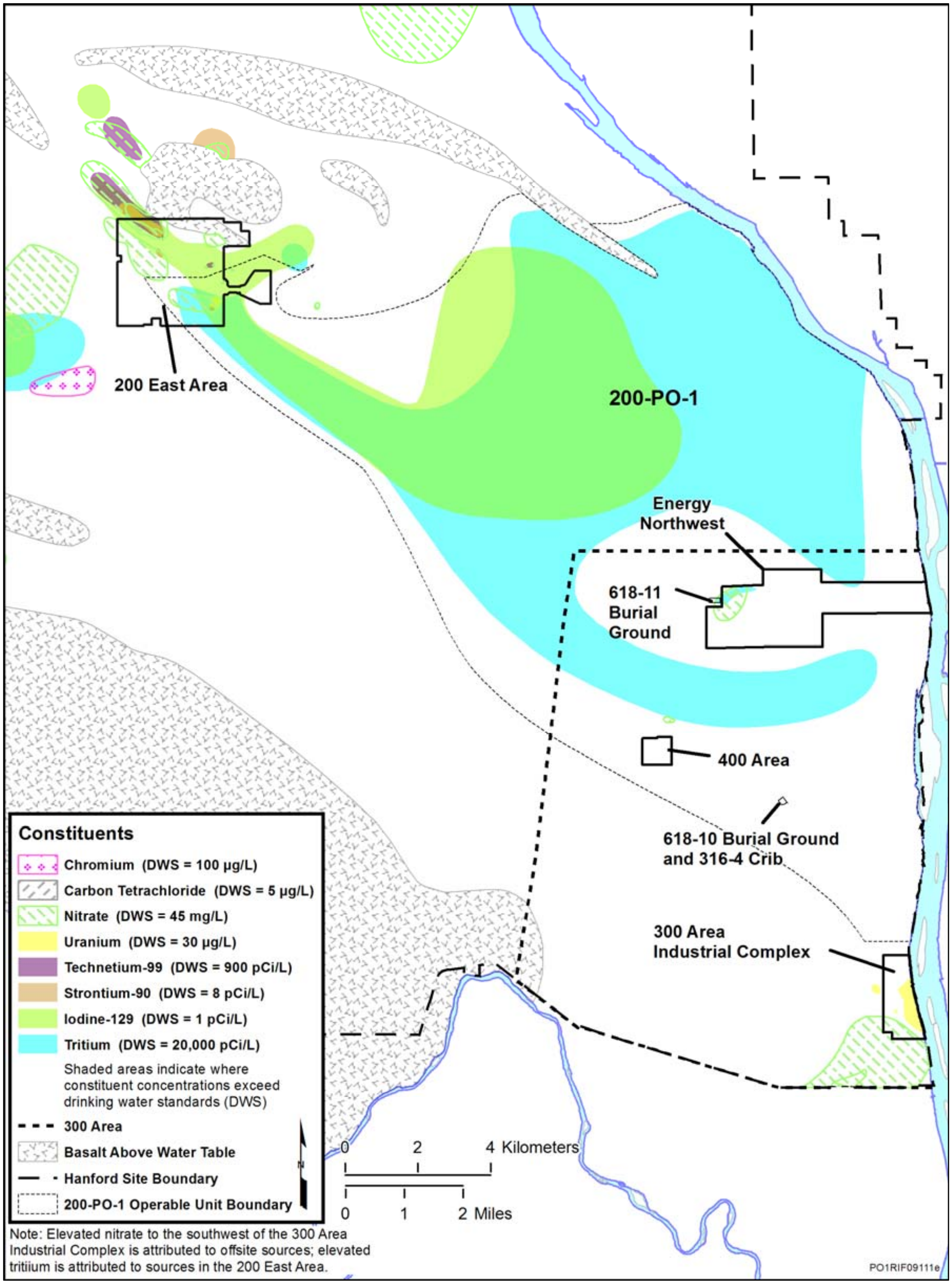


Figure 5. 200-PO-1 Groundwater Operable Unit Contaminant Plumes

Based on treatability testing, the use of phosphate to sequester uranium as autunite is considered a feasible technology to enhance uranium attenuation processes in deep soils. Direct injection of phosphate to the aquifer can be used to treat uranium in groundwater. Phosphate infiltration, supplemented with injection of phosphate into the lower portion of the vadose zone and the PRZ, is also considered a feasible approach to sequester a portion of the mobile uranium in soil above the groundwater table that continues to leach to the aquifer.

Previous Cleanup Actions

The Tri-Parties conducted two removal actions in 1991 to mitigate the threat to HHE from contaminant migration, primarily uranium, in the 300 Area: (1) removal of soil from the 300 Area Process Trenches (316-5) in the 300-FF-1 OU, and (2) removal and disposal of drums containing uranium-contaminated methyl isobutyl ketone (hexone) from the 618-9 Burial Ground in the 300-FF-2 OU.

Beginning in 1996, the remedial action implemented for uranium contamination in the groundwater, as specified in the 1996 interim action ROD for the 300-FF-5 OU, was (1) continued groundwater monitoring to verify modeled predictions of contaminant attenuation, and (2) ICs to restrict groundwater use to prevent unacceptable exposures. Groundwater monitoring has shown that uranium contamination did not decline to the DWS within the expected 10 years identified in the interim action ROD. The persistence of uranium contamination in groundwater is attributed to the continuing source of uranium contamination in the PRZ, with the highest concentration at the southern end of the 316-5 Process Trenches.

In 1997, remediation of contaminated waste sites was initiated in the 300-FF-1 OU as a final action under the 1996 ROD for the 300-FF-1 OU. These waste sites included the primary liquid waste disposal sites (e.g., South Process Pond [316-1], North Process Pond [316-2], and 300 Area Process Trenches [316-5]) and solid waste disposal sites (e.g., 618-4 Burial Ground and 628-4 Landfill). Following these remedial actions, the Tri-Parties determined that remediation was complete, as documented in the *300-FF-1 Operable Unit Remedial Action Report* (DOE/RL-2004-74).

In 2001, remediation of contaminated soil was initiated at 52 waste sites in the 300-FF-2 OU as an interim action under the 2001 interim action ROD. The interim actions will continue until final remedies are selected and implemented.

In addition to soil and groundwater remediation, deactivation, decommission, decontamination, and demolition have been completed for many facilities in the 300 Area Industrial Complex as CERCLA removal actions. Demolition activities for 300 Area Industrial Complex facilities are ongoing. As of May 2012, 12 facilities were demolished in the 400 Area. No facilities exist in the 600 Area portion of the 300-FF-2 OU that require removal.

During the ongoing CERCLA waste site remedial actions and facility removal actions, generated waste is initially assessed for radionuclide content to determine if it is eligible for disposal at the onsite ***Environmental Restoration Disposal Facility (ERDF)*** or if it may require offsite disposal at a national repository. Suspect TRU waste has been identified during the initial assessment of waste generated by the remedial and removal actions. Most of this waste identified in the initial assessment as suspect TRU has been shipped to an offsite commercial processor for treatment, size reduction, and packaging, as needed. The waste was then transferred to the Hanford Site Central Waste Complex for thorough measurements to determine whether it is TRU waste, ERDF-eligible waste, or another category of waste. A remaining, smaller portion of waste identified as suspect TRU based on the initial assessment has been shipped directly to Hanford's Central Waste Complex. The following quantities of waste were generated from August 2005 through September 2012:

- **Waste site remedial action suspect TRU waste:** 0.3 metric tons (0.3 tons)
- **Waste site remedial action waste to ERDF:** 737,679 metric tons (813,318 tons)

- **Facility removal action suspect TRU waste:** 35 metric tons (38 tons)
- **Facility removal action waste to ERDF:** 125,819 metric tons (138,720 tons)

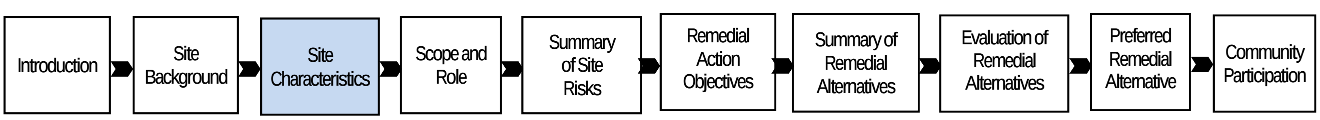
Previous Public Participation

The *Hanford Public Involvement Plan* (DOE et al., 2012) outlines ways that the public can become involved in Hanford Site cleanup decisions and summarizes information about government and public organizations involved with Hanford Site issues, including Oregon State and the Hanford Advisory Board (a federally chartered advisory board made up of representatives of diverse stakeholders concerned with Hanford Site cleanup). The historical input and advice from all parties relative to the 300-FF-1, 300-FF-2, and 300-FF-5 OUs were reviewed in the development of this Proposed Plan.

In addition to public dialogue with stakeholders and consultation with the Tribal Nations, the Tri-Parties conducted formal public involvement during the previous decision processes for soil and groundwater cleanup for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs, as well as for deactivation and decommissioning of buildings in the 300 Area. A list of the relevant decision documents is provided in the "Scope and Role" section of this Proposed Plan.

Previous Tribal Nation Participation

The Hanford Site is located on land ceded to the United States under separate treaties with the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The Nez Perce Tribe also secured rights on what is now the Hanford Site in its separate treaty. In addition, DOE consults with the Wanapum Band of Indians, who were historical residents on Hanford lands. During preparation of this Proposed Plan, DOE and EPA invited the Tribal Nations to formal consultation on this proposed cleanup action. EPA also invited the Tribal Nations to participate in EPA's National Remedy Review Board review of this proposed cleanup action. In addition to these formal activities, DOE and EPA have worked with Tribal staff during the RI/FS process.



Site Characteristics

The discussion in this section presents information on the site surface features, current land and groundwater uses, the contamination release conceptual model, and the associated groundwater contaminant plumes.

Site Features and Land and Groundwater Use

Major facilities and roads outside the 300 Area Industrial Complex are shown on Figure 3, and facilities and roads within the 300 Area Industrial Complex (in June 1976) are shown on Figure 4. Demolition of 300 Area Industrial Complex facilities is ongoing. The list of long-term facilities and utilities (in support of the continuing mission of Pacific Northwest National Laboratory (PNNL) in the 300 Area that will be retained through at least 2027) is provided in the 300 Area RI/FS report (Table 1-2 in DOE/RL-2010-99). In addition, industrial activities continue in the 300 Area that are associated with electrical power generation (Energy Northwest), training (HAMMER), and security (Hanford Patrol Academy). Deactivation activities were completed at the FFTF reactor (400 Area), which was placed in long-term, low-cost surveillance and maintenance in 2009.

Within the 300 Area, groundwater is withdrawn from three water supply wells by Energy Northwest for drinking water and fire protection, and from three water supply wells in the 400 Area for drinking water. Groundwater samples from these water supply wells are monitored. In addition, groundwater contaminated with uranium is withdrawn from one well by PNNL to supply water to aquariums used for fisheries research in the 331 Life Sciences Laboratory. Groundwater is also used to supply water for dust suppression during CERCLA remediation activities. The City of Richland provides potable water to the 300 Area Industrial Complex facilities.

Many communities downstream of the 300 Area and overall Hanford Site draw water from the Columbia River for all or part of their domestic water supply. The City of Richland's water uptake from the Columbia River, approximately 4 km (2.5 mi) downstream from the 300 Area, is the closest to the Hanford Site. The City of Richland provides an annual drinking water report to comply with the *Safe Drinking Water Act of 1974*. No alternate water sources have been required for the City of Richland due to contamination resulting from Hanford Site operations.

Physical Features Affecting Remedy Selection

The ground surface of the 300 Area is flat inland from the Columbia River, the principal surface water feature in the area. Topographic changes are the greatest near the Columbia River, where the riverbank slopes steeply to the water. Surface elevations change from approximately 137 m (449 ft) above mean sea level at the inland 618-11 Burial Ground to approximately 115 m (377 ft) at the 300 Area Industrial Complex.

The vadose zone is comprised of backfill materials and unconsolidated gravels and sand of the Hanford formation. In the 300 Area Industrial Complex, the average thickness of the vadose zone in the area of the waste sites is 10 m (33 ft); the thickness of the vadose zone at the 618-10 Burial Ground, the 618-11 Burial Ground, and the 400 Area is 21 m (68 ft), 19 m (63 ft), and 31 m (125 ft), respectively.

As the river water level fluctuates up and down seasonally, the groundwater throughout the 300 Area Industrial Complex next to the river also fluctuates. Rising groundwater saturates what usually is the deep layer of the vadose zone. In some years, the river water is much higher and remains high for much longer than in most years, and resulting elevated groundwater saturates deep vadose zone layers that may not have been wet for years. This fluctuating groundwater elevation creates the PRZ.

The unconfined aquifer occurs in the highly permeable, gravel-dominated Hanford formation and in the underlying, less permeable sands and gravels of Ringold Formation (Figure 6). The Ringold Formation lower mud unit is a ***confining layer***, the ***aquitard*** at the base of the unconfined aquifer, and is characterized by very low permeability, fine-grained sediment. This hydrologic unit prevents further downward movement of groundwater contamination to the deeper aquifers. The thickness of the unconfined aquifer along the Columbia River shoreline is about 25 m (80 ft).

Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank springs and seeps. The flux from the Hanford Site aquifer is very low compared to the flow of the river. Because the river stage regularly fluctuates up and down, flow beneath the shoreline is back and forth, with river water intruding into the unconfined aquifer and mixing with groundwater. When the river stage drops quickly to a low elevation, riverbank springs appear.

Groundwater flow velocities beneath the 300 Area are rapid, with rates up to 18 m/day (59 ft/day) having been observed. However, the ***hydraulic gradients*** change direction in response to river stage, which fluctuates on seasonal and multiyear cycles. Consequently, groundwater flow is not always directed toward the river.

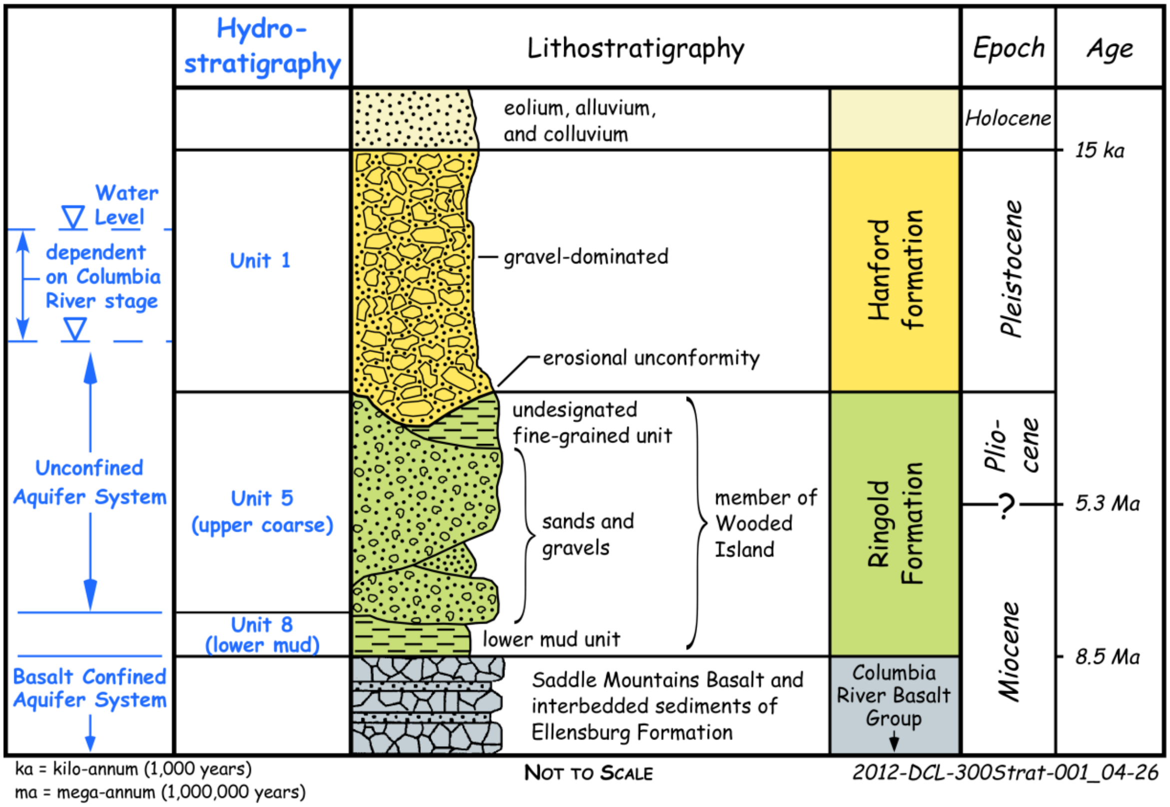


Figure 6. Stratigraphy of the 300 Area

In general, regional groundwater flow converges from the northwest, west, and southwest, inducing an east-southeast flow direction in the 300 Area. During periods of extended high river stage (March through June), water flows from the river into the groundwater. The rise and fall of the river stage creates a dynamic zone of interaction between groundwater and river water (Figure 7), affecting groundwater flow patterns, contaminant transport rates (e.g., uranium in groundwater), groundwater geochemistry, contaminant concentrations, and ***attenuation rates***.

Key geohydrologic factors considered in the remedy selection for deep uranium are the interaction between the groundwater and the Columbia River, the relatively high permeability of the sands and gravels in the vadose zone and unconfined aquifer, and the lateral extent of the PRZ. When groundwater rises into the PRZ, it mobilizes residual mobile uranium contamination. Some of the mobilized residual uranium moves vertically to groundwater, some moves laterally to the nearby PRZ, and some is redeposited near the original location. In addition to river water fluctuations, small amounts of precipitation periodically leach down toward the groundwater, which can further move uranium contamination to the PRZ and groundwater. Thus, the deep uranium contamination spreads vertically and laterally with each high water event and periodically with precipitation water. This periodic input of mobile uranium to the groundwater results in a persistent uranium plume and continued discharge of relatively low uranium concentrations to the river until the source of uranium is depleted.

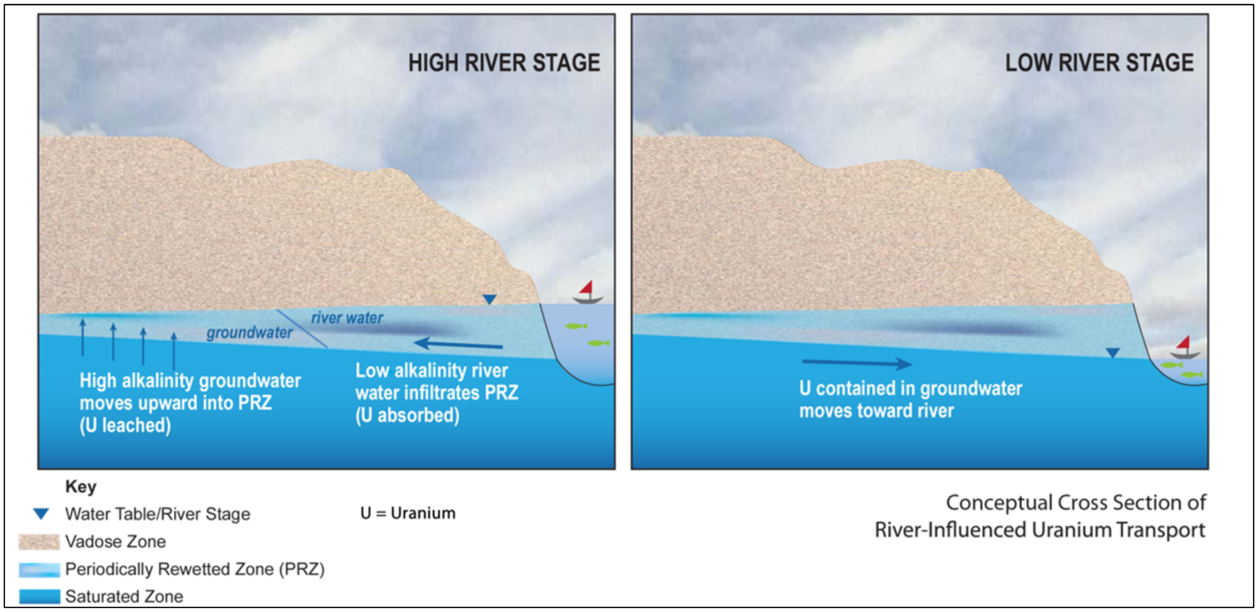


Figure 7. High and Low River-Stage Effects on Groundwater in the 300 Area

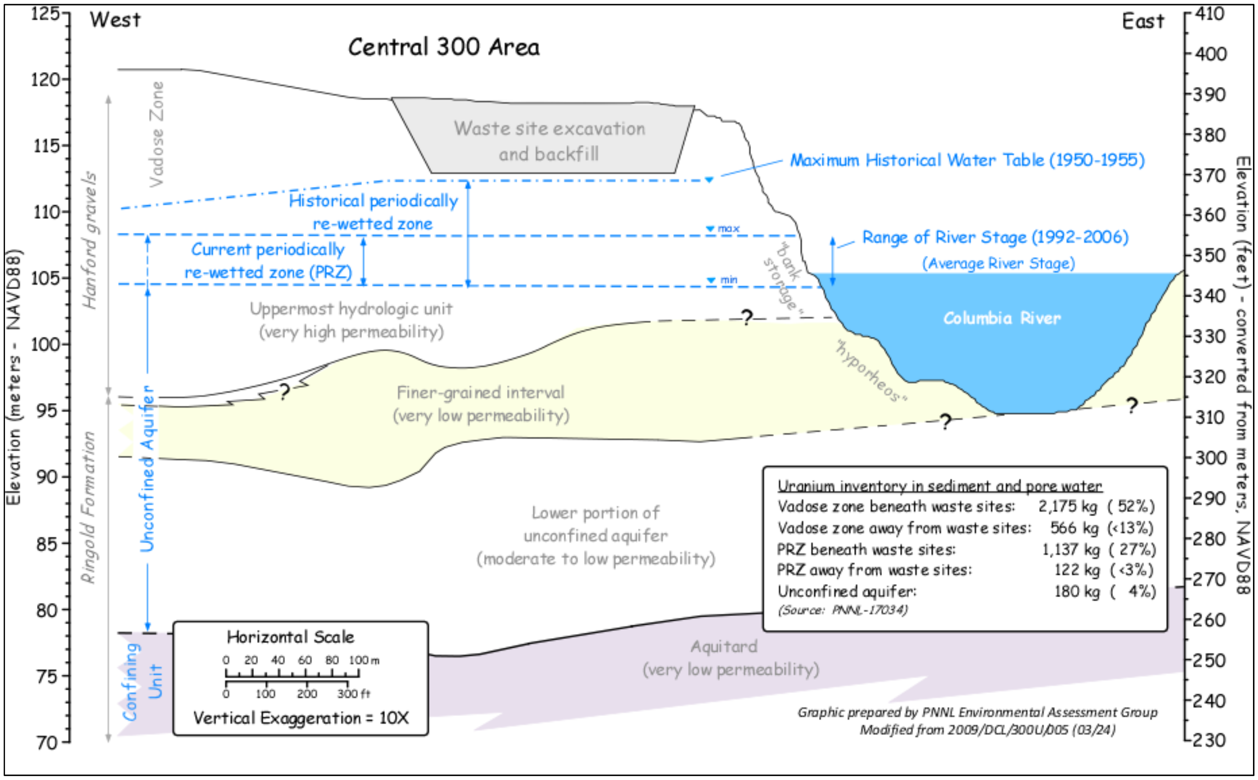
The development of alternatives in the RI/FS, which also are presented here, considered the extent of contamination, rates of attenuation, and the benefits and problems associated with technologies available to address mobile uranium in the deep vadose zone and PRZ. The lateral extent of the PRZ limits the effectiveness of several technologies, including deep excavation, as a remedy to remove contamination that has migrated vertically to the PRZ and laterally away from the footprint of the waste site sources.

Waste Site Contamination

The liquid waste discharged to the 300-FF-1 and 300-FF-2 OUs contained nitrate, uranium and other metals, and organics. Most of the mobile contaminants (e.g., nitrate) have migrated through the vadose zone to groundwater. The solid waste disposed in burial grounds contained uranium, plutonium (primarily in the 618-2 Burial Ground, 618-10 Burial Ground, and 618-11 Burial Ground), tritium, and nitrate. The solid waste was buried up to 8 m (25 ft) below ground.

The largest amount of residual uranium is in the vadose zone beneath former liquid waste disposal sites South Process Pond (316-1), North Process Pond (316-2), and 300 Area Process Trenches (316-5). The second largest inventory is found in the PRZ below these waste sites. Measurements were made to characterize the uranium inventories in the 300 Area Industrial Complex (PNNL-17034, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington*). A summary of the residual uranium inventories is presented on Figure 8.

Soil sampling in the southwestern portion of the North Process Pond (316-2) near the former effluent inlet and in the southern portion of the 300 Area Process Trenches (316-5) identified elevated uranium concentrations in the vadose zone and PRZ. Uranium concentrations increase in groundwater at these locations when the water table rises during high river stage, indicating that these locations constitute significant sources of ongoing groundwater contamination. Soil sampling at the 307 Process Trenches (316-3) and the 307 Retention Basins identified uranium concentrations in the vadose zone under the central and eastern portions of the 307 Process Trenches and on the eastern side of the 307 Retention Basin.



Source: PNNL-17034, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington*.

Figure 8. Principal Subsurface Features and Uranium Inventory Estimates

In addition to the liquid waste sites, five burial ground sites have been characterized as continuing to contribute uranium to groundwater:

- At the 618-1 and 618-2 Burial Grounds, low concentrations of residual uranium contamination remain in the deep vadose zone where it has been affected by historical high water table conditions, when the historical uranium plume contained higher concentrations and was dispersed away from the principal liquid waste disposal facilities. The 618-1 and 618-2 Burial Grounds received solid waste containing uranium from fuel fabrication facilities. Waste acid contaminated with uranium was discharged to a neutralization pit (300-246) that was constructed in the southwest corner of the 618-1 Burial Ground.
- The 618-3 Burial Ground received solid waste (primarily building materials) containing uranium. Residual uranium contributes to groundwater contamination.
- At the 618-7 Burial Ground, a new area of uranium contamination in groundwater developed in 2008 as a result of infiltration of dust-control water during implementation of interim remedial action. Uranium concentrations at nearby downgradient wells subsequently decreased. However, during the unusually high water table conditions in 2011, the uranium concentration temporarily increased because of the presence of mobile uranium in the lower portion of the vadose zone at this location. The 618-7 Burial Ground received solid waste containing uranium from fuel fabrication processes.

- The 618-10 Burial Ground and adjacent 316-4 Crib are the sources of uranium detected in groundwater at the 618-10 Burial Ground site. Uranium concentrations in nearby downgradient wells increased in 2004 and again in 2012 following application of dust-control water during implementation of interim remedial action. The 316-4 Crib received liquid waste containing uranium.

- The 618-10 and the 618-11 Burial Grounds contain a broad spectrum of low-level radioactive waste, including fission products and byproduct waste (thorium and uranium), as well as waste with TRU constituents. The 618-11 Burial Ground was the source of nitrate and also tritium gas that interacted with vadose zone moisture and eventually entered groundwater.

Investigation of the soils beneath the 324 Building indicates that cesium-137 contamination extends at least 1.5 m (5 ft) below the building floor (4.0 m [13 ft] below grade), and strontium-90 contamination extends at least 9.1 m (30 ft) below grade, which is approximately 7.6 m (25 ft) above average groundwater levels. The contamination was discovered during deactivation and decommissioning activities at the building in 2009 but likely resulted from a 1986 ***unplanned release (UPR)*** of liquid within the B cell. A portion of the spill is believed to have migrated from the cell through a leak in the floor (300-296).

The extent of waste site contamination is illustrated by the locations of the waste sites shown on Figures 9 and 10. These figures show only those waste sites that pose an unacceptable risk. Because of the number and proximity of the waste sites, two figures are used to depict the contamination extent. Figure 9 presents the waste sites that were not included in the cost estimate (Appendix K of the 300 Area RI/FS report [DOE/RL-2010-99]) because remediation was expected to begin under the interim action ROD for the 300-FF-2 OU. Figure 10 presents the waste sites that were included in the cost estimate presented in this Proposed Plan.

Groundwater Contamination

Groundwater contaminants that are at levels that exceed federal or state DWSs (***maximum contaminant levels [MCLs]***) in the 300-FF-5 OU are uranium, tritium, nitrate, TCE, and cis-1,2-dichloroethene. Groundwater contaminants do not exceed ecological protection federal or state standards near the river or where groundwater discharges into the river.

Uranium. The uranium plume in groundwater that exceeds the 30 µg/L DWS covers approximately 0.5 km^2 (0.2 mi^2) in the 300 Area Industrial Complex. Much smaller uranium groundwater plumes are downgradient of the 618-7 and 618-10 Burial Grounds. The volume of the main uranium plume is approximately 1,000,000 m^3 (35 million ft^3), with a dissolved uranium mass that typically ranges from 40 to 80 kg. The extent of Columbia River shoreline where uranium concentrations exceed the DWS during low river stage is approximately 1,200 m (3,400 ft). Figure 11 presents the groundwater uranium plumes for winter (low river stage) and summer (high river stage) seasons during 2011.

Tritium. Tritium in groundwater that exceeds the 20,000 ***picocurie*** per liter (pCi/L) DWS occurs in five wells downgradient from the 618-11 Burial Ground. Tritium concentrations from the 618-11 Burial Ground do not, and are not predicted to, affect the Columbia River above the DWS (Section 5.7.4 of the 300 Area RI/FS report [DOE/RL-2010-99]). The extent of the tritium plume is shown on Figure 4-73 in the 300 Area RI/FS report.

Nitrate. Nitrate in the 300 Area Industrial Complex exceeds the 45 mg/L DWS in areas where groundwater has been affected by offsite activities. Elevated nitrate concentrations are detected in the southern portion and reflect the migration onsite of nitrate-contaminated groundwater into the area from sources to the southwest. The extent of the nitrate plume is shown on Figure 4-70 in the 300 Area RI/FS report (DOE/RL-2010-99).

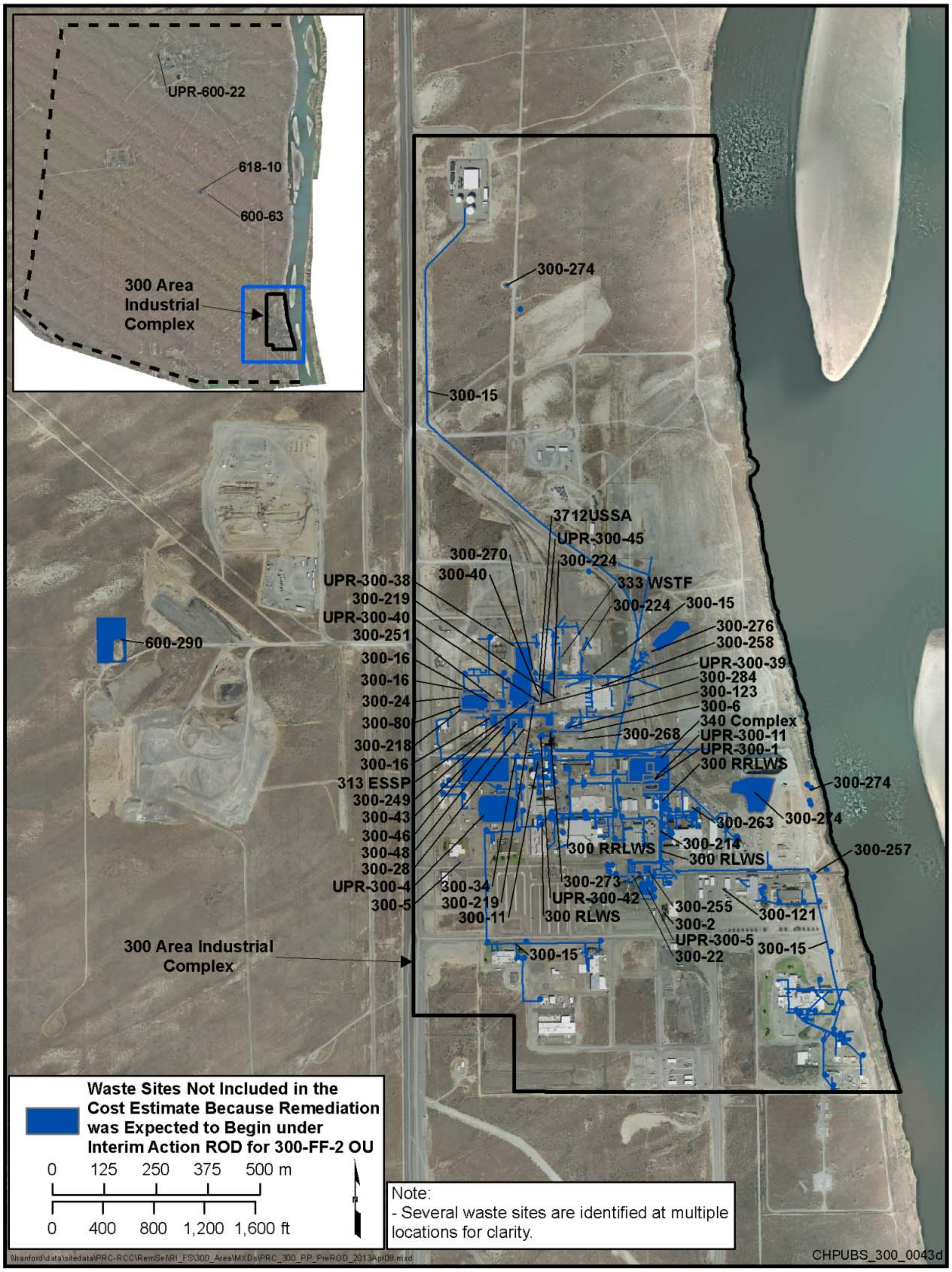


Figure 9. Waste Sites (52) Not Included in the Cost Estimate Presented in this Proposed Plan (Expected to Begin Remediation under the 300-FF-2 OU Interim Action ROD)

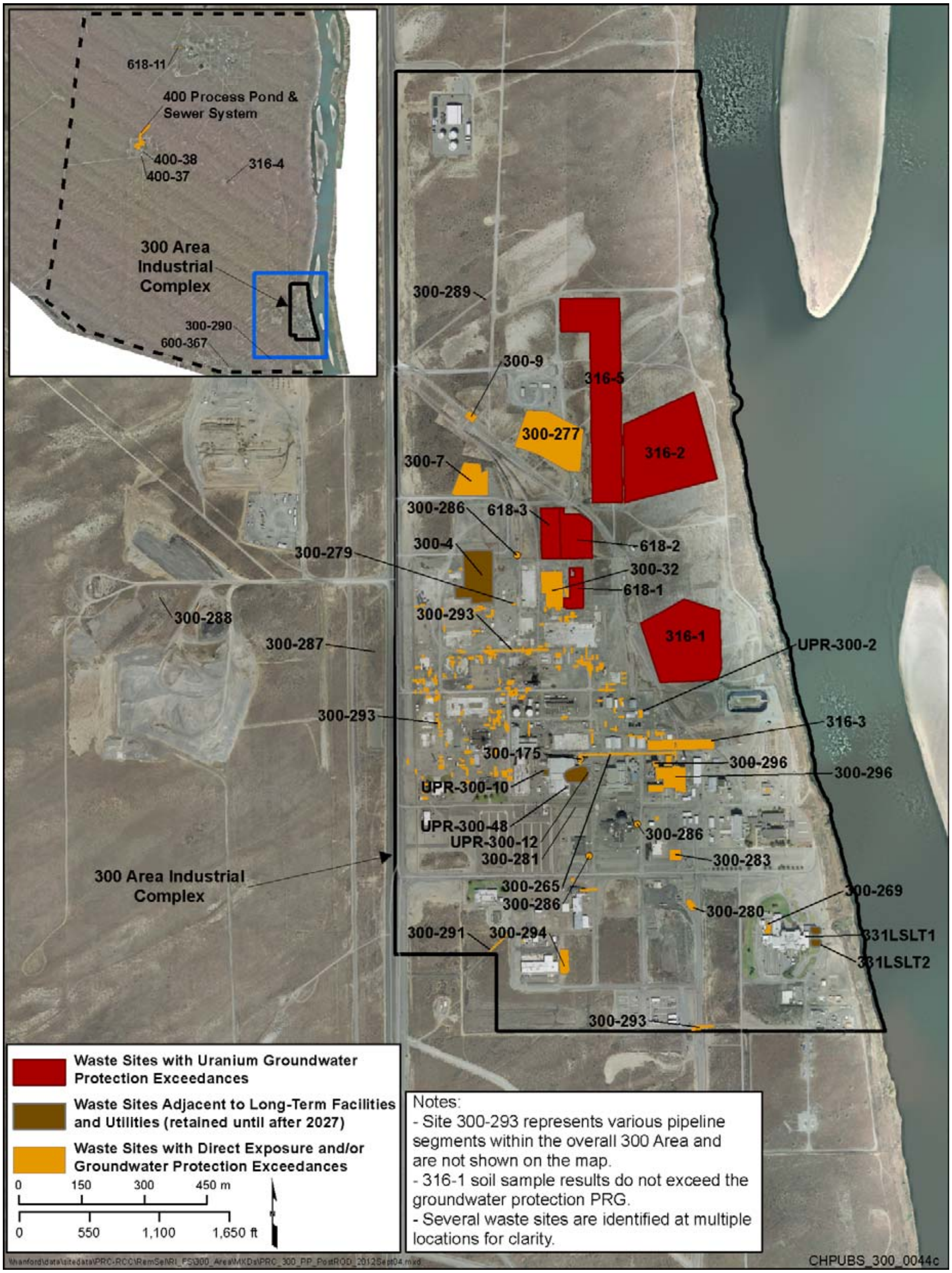


Figure 10. Waste Sites (40 Total) Included in the Cost Estimate Presented in this Proposed Plan

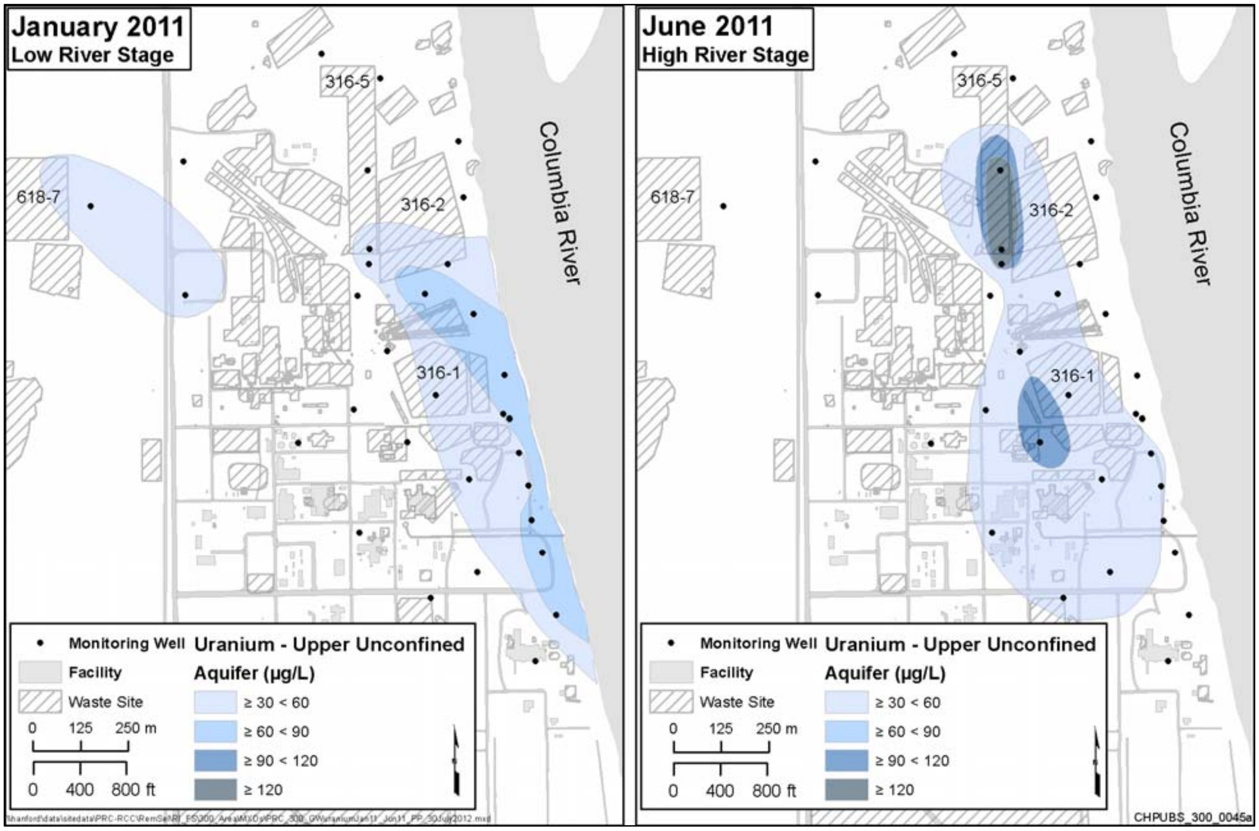


Figure 11. Uranium Plume in Groundwater Beneath the 300 Area, Winter and Summer 2011

Nitrate concentrations also exceed the DWS at four wells downgradient from the 618-11 Burial Ground. The extent of the nitrate plume is similar to the extent of the tritium plume shown on Figure 4-73 in the 300 Area RI/FS report (DOE/RL-2010-99).

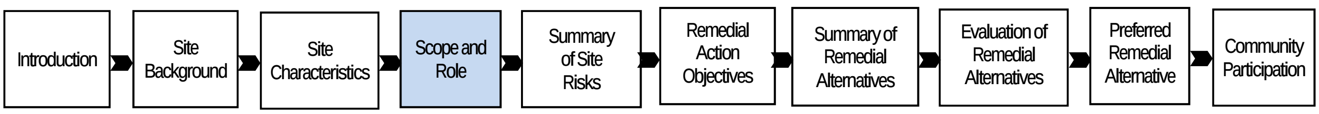
Volatile Organic Compounds. Volatile organic compounds (VOCs) that exceed the DWS in 300 Area groundwater include TCE and cis-1,2-dichloroethene. For wells monitoring the unconfined aquifer, only two samples were collected during the past 5 years that exceeded the 5 µg/L DWS for TCE. No TCE detections have been made in samples collected from wells monitoring the confined aquifer beneath the unconfined aquifer system. The extent of the TCE in groundwater is shown on Figure 4-66 in the 300 Area RI/FS report (DOE/RL-2010-99).

Cis-1,2-dichloroethene has been detected consistently at concentrations exceeding the 70 µg/L DWS at a well located near the southern boundary of the former North Process Pond (316-2). The well monitors groundwater near the bottom of the unconfined aquifer in sandy gravel sediment of relatively low permeability. The origin for cis-1,2-dichloroethene is attributed to degradation of TCE disposed to the Process Trenches and/or North Process Pond (PNNL-17666, *Volatile Organic Compound Investigation Results, 300 Area, Hanford Site, Washington*). In 2011, cis-1,2-dichloroethene was also detected above the DWS at a new RI well located approximately 80 m (262 ft) further downgradient and screened at mid-depth in the unconfined aquifer.

Principal Threat Wastes

Principal threat wastes are those source materials considered highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to public health or the environment should exposure occur.

Three sites in the 300-FF-2 OU contain principal threat waste. Principal threat waste containing the long-lived TRU radionuclides plutonium and americium was placed in the 618-10 and 618-11 Burial Grounds, which were developed specifically for such disposal. High radioactivity associated with cesium-137 and strontium-90 has been identified as principal threat waste in the soil beneath the B cell of the 324 Building. Alternatives 2, 3, 3a, 4, and 5 include treatment for this waste.



Scope and Role

This Proposed Plan addresses the risk from releases and potential releases in the following OUs:

- 300-FF-1 waste sites OU (three sites containing uranium contamination in the deep vadose zone and PRZ as a risk to groundwater)
- 300-FF-2 waste sites OU (127 sites)
- 300-FF-5 groundwater OU

The portions of the 300 Area shown on Figure 3 that are not included in these OUs include the following:

- Hanford Patrol Training Academy, including the firing ranges (active facility)
- FFTF reactor and associated structures (now inactive)
- Energy Northwest and Bonneville Power Administration facilities (active facilities)
- HAMMER training and education facility (active facility)
- Groundwater contamination emanating from the 200 Areas (addressed in the 200-PO-1 OU)

This section describes the role of the 300-FF-1, 300-FF-2, and 300-FF-5 OUs in the scope of the Hanford Site cleanup strategy.

Hanford Site Overall Cleanup Strategy

The process for characterizing and remediating waste sites at the Hanford Site is addressed by the Tri-Party Agreement (Ecology et al., 1989). The River Corridor and the Central Plateau (Figure 2) are the two main geographic areas of cleanup work on the Hanford Site. The River Corridor includes the former fuel fabrication and reactor operations areas adjacent to the Columbia River. The Central Plateau includes the former fuel processing facilities and numerous waste disposal facilities. Cleanup of Hanford Site contamination in the Central Plateau and River Corridor is being accomplished by dividing these main geographic areas into a number of specific OUs.

The Hanford cleanup strategy includes (1) removing contamination near the Columbia River to support reasonably anticipated future uses, protect the environment, restore groundwater to beneficial use, and ensure the aquatic life in the Columbia River is protected; and (2) moving the contaminated material to the Central

Plateau or other EPA-approved disposal facility in accordance with CERCLA remedy requirements. The intent is to shrink the Hanford Site footprint to the Central Plateau Inner Area for long-term waste management. Long-term industrial activities will continue in the 300 Area. The strategy includes restoring groundwater beneath the Hanford Site to DWSs and ensuring that aquatic life in the Columbia River is protected by achieving ***ambient water quality criteria*** in areas where groundwater discharges to surface water.

Contaminated groundwater migrating into the 300 Area from the 200 Areas will be addressed under a separate ROD for the 200-PO-1 OU. The FFTF is not included in the 300-FF-2 OU and this Proposed Plan. The FFTF and related facilities were evaluated in the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (DOE/EIS-0391).

Previous Cleanup Decisions

Several CERCLA and *Resource Conservation and Recovery Act of 1976* (RCRA) decisions have been made for the 300 Area, as listed below. Figure 12 presents a chronology of key documents that have been prepared and activities that have been implemented for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs since the 300 Area was added to the NPL (40 CFR 300, Appendix B).

Interim Action Records of Decision. Interim actions were initiated in the 300 Area in 1996 for contaminated groundwater in the 300-FF-5 OU and in 2001 for contaminated waste sites in the 300-FF-2 OU. These interim actions are still underway and are proposed to be superseded by the remedy selected in a final ROD resulting from this Proposed Plan.

- **1996:** *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington* (EPA/ROD/R10-96/143) (final action for the 300-FF-1 OU and interim action for the 300-FF-5 OU)
  - **2000:** *Explanation of Significant Difference for 300-FF-5 Operable Unit Record of Decision* (EPA/ESD/R10-00/524)
- **2001:** *EPA Superfund Record of Decision: Hanford 300-Area, Benton County, Washington* (EPA/ROD/R10-01/119) (interim action for the 300-FF-2 OU)
  - **2004:** *Explanation of Significant Difference for 300-FF-2 Operable Unit Record of Decision* (EPA et al., 2004)
  - **2009:** *Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Action Record of Decision Hanford Site Benton County, Washington* (EPA et al., 2009)
  - **2011:** *Explanation of Significant Differences, Hanford 300 Area, 300-FF-2 Operable Unit, 618-10 Burial Ground* (EPA et al., 2011)

Record of Decision. A final action ROD was issued for the 300-FF-1 OU. The remediation activities specified in the 300-FF-1 OU ROD are complete. However, it has been determined that additional action is needed to address uranium leaching into the groundwater.

- **1996:** *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington* (EPA/ROD/R10-96/143) (final action for the 300-FF-1 OU and interim action for the 300-FF-5 OU)
  - **2000:** *USDOE Hanford 300 Area, 300-FF-1 Operable Unit, Hanford Site, Benton County, Washington Explanation of Significant Difference (ESD)* (EPA/ESD/R10-00/505)

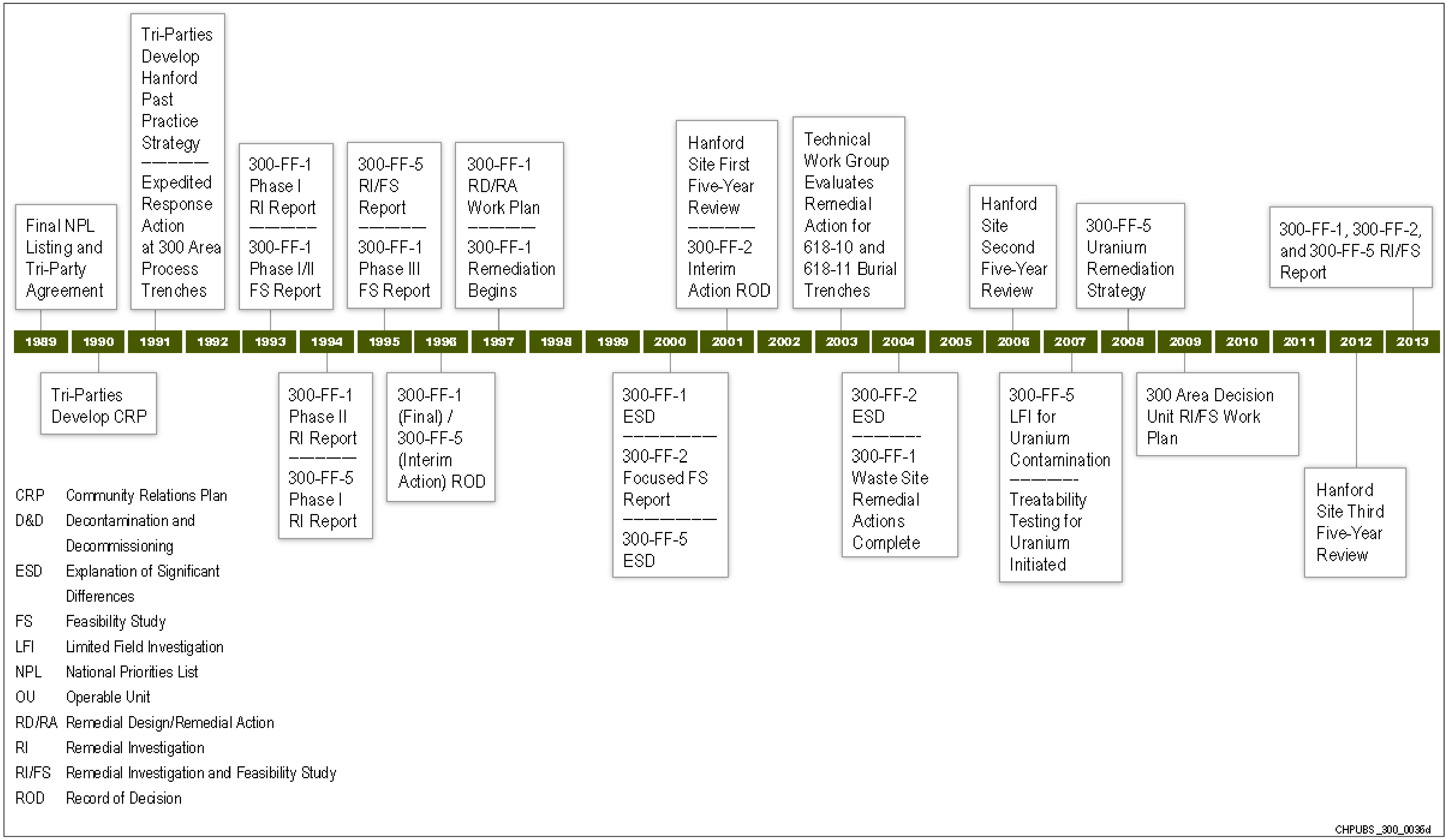


Figure 12. 300 Area Investigation and Remediation Timeline

Removal Action Memoranda (Facilities). The following action memoranda address facility decommissioning and removal:

- *331-A Virology Laboratory Building Action Memorandum* (DOE and EPA, 2000)
- *Action Memorandum #1 for the 300 Area Facilities* (DOE and EPA, 2005)
- *Action Memorandum #2 for the 300 Area Facilities* (DOE and EPA, 2006a)
- *Action Memorandum #3 for the 300 Area Facilities* (DOE and EPA, 2006b)
- *Action Memorandum for General Hanford Site Decommissioning Activities* (DOE/RL-2010-22)

Removal Action Memorandum/Expedited Response Action Memorandum (Waste Sites). Two removal actions were conducted in 1991 to mitigate the threat to HHE from contaminant migration in the 300 Area (i.e., removal of soil from the 300 Area Process Trenches in the 300-FF-1 OU, and removal and disposal of drums containing uranium-contaminated hexone from the 618-9 Burial Ground in the 300-FF-2 OU):

- *618-9 Burial Ground Expedited Response Action* (DOE, 1991)
- *Action Memorandum: 316-5 Process Trenches, U.S. Department of Energy (DOE) Hanford Site, Richland, Washington* (EPA, 1991a)

Five-Year Review Reports. CERCLA and the NCP (40 CFR 300) require that remedial actions resulting in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed at least every 5 years after initiation of the selected remedial action to ensure that HHE are being protected by the remedial action. Three 5-year reviews have been completed for the Hanford Site:

- **2001:** *USDOE Hanford Site First Five Year Review Report* (EPA, 2001)
- **2006:** *The Second CERCLA Five-Year Review Report for the Hanford Site* (DOE/RL-2006-20)
- **2012:** *Hanford Site Third CERCLA Five-Year Review Report* (DOE/RL-2011-56)

The second 5-year review identified the following issue:

> *Predicted attenuation of uranium contaminant concentrations in the groundwater under the 300 Area has not occurred. DOE is currently performing additional characterization and treatability testing in the evaluation of more aggressive remedial alternatives.*

To address this issue, the review put forth the following actions: (1) provide additional characterization of the 300-FF-5 OU uranium contamination, (2) develop a conceptual model, (3) validate ecological consequences, (4) evaluate treatment alternatives, and (5) concurrently test polyphosphate injection into the aquifer. DOE completed all of these actions, as described in the 300 Area RI/FS report (Section 1.3.2.1 of DOE/RL-2010-99).

The third 5-year review was completed in 2012 and included an action to issue this Proposed Plan for a ROD to support meeting groundwater remediation goals.

RCRA Treatment Storage and/or Disposal Units, Active. Two RCRA treatment, storage, and/or disposal (TSD) units are currently permitted to operate in the 300 Area: the 325 hazardous waste treatment units and the 400 Area waste management unit (400-40). Closure of these TSD units will occur in accordance with the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967).

RCRA Treatment Storage and/or Disposal Units, Closure. The following 14 RCRA TSD units in the 300 Area Industrial Complex have been certified by DOE as clean closed between 1995 and 2011:

- 300 Area Solvent Evaporator
- 304 Concretion Facility
- Thermal Treatment Test Facilities
- Physical and Chemical Treatment Test Facilities
- Biological Treatment Test Facilities
- 332 Storage Facility
- 324 Pilot Plant
- 3718-F Alkali Metal Treatment and Storage Area
- 311 Tanks Capacity
- 303-K Storage Facility
- 300 Area Waste Acid Treatment System
- 303-M Oxide Facility
- 305-B Storage Facility
- 331-C Storage Unit

The 324 Building is planned to be closed under the *324 Building Radiochemical Engineering Cells, High-Level Vault, Low-Level Vault, and Associated Areas Closure Plan* (DOE/RL-96-73) and coordinated with CERCLA Action Memorandum #2 (DOE and EPA, 2006a).

The following three RCRA TSD units in the 400 Area have been certified by DOE as clean closed between 1997 and 2003:

- 4843 Alkali Metal Storage Facility
- 437 Maintenance and Storage Facility
- Sodium Storage Facility and Sodium Reaction Facility

The following RCRA TSD unit in the 600 Area has been certified by DOE as clean closed in 1995: Hanford Patrol Academy Demolition Sites.

There was no residual radionuclide contamination following the RCRA closure, and no subsequent waste site was identified.

RCRA Treatment Storage and/or Disposal Units, Post-Closure. The 300 Area Process Trenches were a RCRA TSD unit that consisted of two parallel, unlined infiltration trenches. Closure activities have been certified by DOE as completed. Post-closure groundwater monitoring required by RCRA is conducted in accordance with the *300 Area Process Trenches Modified Closure/Postclosure Plan* (DOE/RL-93-73), which is incorporated into the Hanford Facility Dangerous Waste Permit (WA7890008967).

Principal Threat Waste Approach

The NCP (40 CFR 300.430[a][l][iii][A]) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Where the toxicity and mobility of source material combine to pose a potential human health ***excess lifetime cancer risk (ELCR)*** greater than one in a thousand (1×10^{-3}), treatment alternatives should be identified (*A Guide to Principal Threat and Low Level Wastes* [EPA, 1991b]).

The RTD component of the alternatives in this Proposed Plan will isolate the highly radioactive materials posing the principal threat and grout, as appropriate, to reduce the dose rate and to stabilize the waste materials. This treatment reduces the toxicity and mobility of the waste. The stabilized materials will be removed to the extent necessary to ensure protection of HHE and will be disposed at an appropriate disposal facility (primarily the ERDF). Waste determined to be TRU will be transported offsite for deep geologic disposal at the Waste Isolation Pilot Plant in New Mexico.

Summary of Site Risks

A baseline risk assessment is required under the NCP to characterize current and potential threats to HHE and to provide information that can be used in the development and evaluation of remedial alternatives. The River Corridor Baseline Risk Assessment (DOE/RL-2007-21, *River Corridor Baseline Risk Assessment, Volume I: Ecological Risk Assessment* and *River Corridor Baseline Risk Assessment, Volume II: Human Health Risk Assessment*; hereafter called the RCBRA), and *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment* and *Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment* (DOE/RL-2010-117, hereafter called the CRC) were conducted to (1) characterize current and potential future risks to HHE, (2) establish a basis for remedial actions, and (3) support final cleanup decisions in the River Corridor. The RCBRA evaluated soil, sediment, and water located in riparian and near-shore areas and consists of a human health risk assessment (HHRA) (DOE/RL-2007-21, Volume II) and an ecological risk assessment (ERA) (DOE/RL-2007-21, Volume I). The CRC provides a comprehensive HHRA (DOE/RL-2010-117, Volume II) and a screening-level ERA (DOE/RL-2010-117, Volume I). The intent of the CRC HHRA (DOE/RL-2010-117, Volume II) was to complete the assessment of the “bank-to-bank” Hanford Reach and downstream areas (i.e., Lake Wallula) of the Columbia River, characterizing risk in areas of the River Corridor not previously addressed under the RCBRA (DOE/RL-2007-21). The results of the RCBRA (DOE/RL-2007-21) and the CRC (DOE/RL-2010-117), which address potential risks from Hanford Site releases to the Columbia River, are summarized in the 300 Area RI/FS report (Chapters 6 and 7 of DOE/RL-2010-99).

The risk evaluation for specific waste sites in the RI/FS relies on a comprehensive review of all available data for each waste site, including field data, radiological surveys, process history, analogous site information, personal interviews, engineering drawings and as-builts, and any other information identified during the development of the RI/FS. For the waste sites proposed for remediation, the data review indicated an unacceptable risk, thus providing a basis for action. This comprehensive review of the characteristics of each site is sufficiently defined for the purpose of alternative development and comparison in the FS.

Land and Groundwater Use Assumptions

Future land-use assumptions allow the baseline risk assessment and the FS to identify risks and focus on identifying and evaluating remedial alternatives. These alternatives should support selection of remedial actions that support the reasonably anticipated future land use.

The 300 Area contains currently active industrial areas. In addition, research and development activities within the 300 Area Industrial Complex are ongoing and are projected to continue within designated facilities through at least the year 2027. This current industrial land use is consistent with the reasonably anticipated future industrial land use that was identified in the previous CERCLA RODs for the 300-FF-1 and 300-FF-5 OUs (EPA/R10-96/143) and the 300-FF-2 OU (EPA/ROD/R10-01/119).

In 1999, DOE issued the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (CLUP) (DOE/EIS-0222-F) and corresponding *Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) (DOE, 1999). Additional evaluation on land use was later performed and DOE issued a *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE/EIS-0222-SA-01) in 2008. DOE included participation from federal agencies; Tribal governments; and state, county, and local governments during preparation of the CLUP (DOE/EIS-0222-F).

In this NEPA ROD, the majority of the 300 Area, including all land around the 300-FF-1 and 300-FF-2 OU waste sites, was designated by DOE for industrial land use. The remainder of the land in the 300 Area was designated by DOE in the NEPA ROD as conservation (mining).

"Establishment of the Hanford Reach National Monument" (65 FR 37253) established the HRNM within the boundaries of the Hanford Site (Figure 2). *Establishment of the Hanford Reach National Monument* (Presidential Proclamation 7319) mandates preservation of the natural environment within the HRNM. Preservation is generally a more restrictive land use than what DOE has designated in the CLUP (DOE/EIS-0222-F). The HRNM mandate is to preserve the natural and cultural resources. The U.S. Fish and Wildlife Service has developed a comprehensive conservation plan for management of the HRNM (*Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement Adams, Benton, Grant and Franklin Counties, Washington* [USFWS, 2008]). There are no 300 Area waste sites within the HRNM.

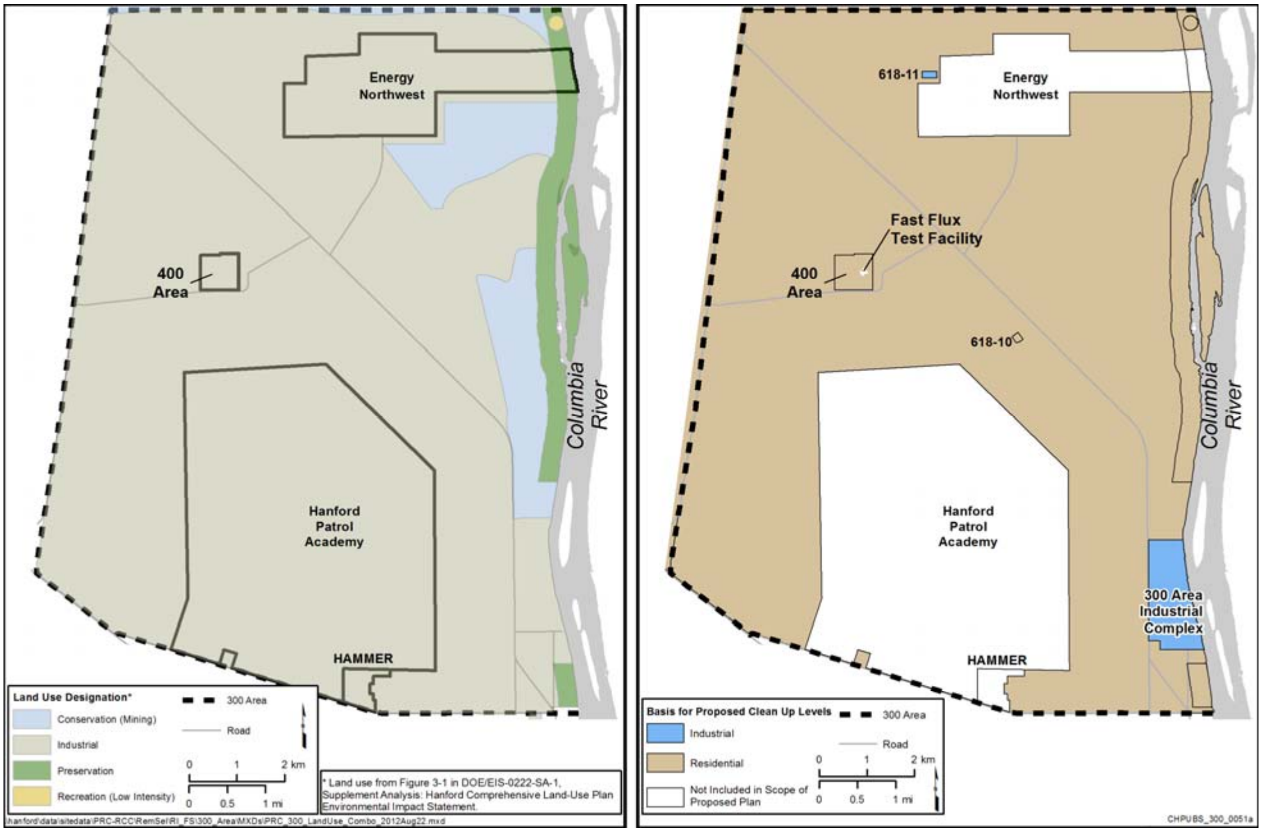
In consideration of previous cleanup and land-use decisions, associated Tribal and public input, and continuing industrial operations, DOE and EPA propose a cleanup strategy supporting industrial and residential exposures, as illustrated in Figure 13. The decision to use cleanup levels based on residential exposure scenarios will minimize institutional controls and long-term monitoring. Figure 13 provides a comparison of anticipated future land use identified in the CLUP to cleanup levels agreed upon by EPA and DOE. As shown in this figure, cleanup to the industrial exposure criteria is limited to the 300 Area Industrial Complex and the 618-11 Burial Ground.

The NCP establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site" (40 CFR 300.430[a][1][iii][F]). The Tri-Parties' goal for Hanford Site groundwater is to attain those regulatory goals by returning groundwater to its beneficial use as a potential future drinking water source.

Some of the groundwater in the 300-FF-5 OU is currently contaminated above DWSs, and withdrawal of this contaminated groundwater for uses other than remediation, research, and monitoring is prohibited via the approved Sitewide institutional control plan (DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*) in accordance with the 300-FF-5 interim action ROD. Under current site use conditions, the only complete human exposure pathway to groundwater in the 300-FF-5 OU is the potential for limited exposure to groundwater from intermittent seeps along the Columbia River. Groundwater in the risk evaluation was evaluated assuming potential use for drinking water and other domestic activities; therefore, contaminant concentrations were compared to DWSs and risk criteria. Groundwater contaminant concentrations were also compared to aquatic criteria, because groundwater discharges to the Columbia River via riverbank seeps and upwelling through the river bottom.

Current and Future Exposure Scenarios

The current human exposure scenario is industrial. Exposure to contamination in the 300 Area is currently controlled by DOE's site controls to prevent unacceptable exposure to humans. Risks to current workers are managed through health and safety programs.



Source: DOE/EIS-0222-SA-01, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (left figure).

Figure 13. Land Use Plan in DOE's NEPA Document (on left), and Exposure Basis for the Proposed Cleanup Levels (on right)

For purposes of assessing future potential risk, various human exposure scenarios were evaluated in the RCBRA (DOE/RL-2007-21, Volume II), the CRC (DOE/RL-2010-117, Volume II), and the baseline human health risk assessment in the 300 Area RI/FS report (Chapter 6 of DOE/RL-2010-99). The 300 Area RI/FS report includes human health risk estimates for residential, industrial, resident national monument worker, casual recreational user, and Tribal exposure scenarios. For the purpose of establishing cleanup levels, EPA and DOE have agreed to use residential and industrial scenarios.

Residential Scenario. The residential scenario for chemicals is the State's "Model Toxics Control Act—Cleanup" (WAC 173-340; hereafter called the ***Model Toxics Control Act [MTCA]***) for unrestricted use. The residential exposure scenario for radionuclides is based on a 30-year residential exposure. Each of these scenarios is described below.

For assessing risks from chemicals in soil, MTCA Method B (WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards") levels are used. For direct contact, these levels are based on exposure of a child through incidental soil ingestion. For the inhalation pathway, MTCA Method B air levels are based on exposure of adults and children from inhalation of vapors and dust in ambient air. Calculations for the soil ***preliminary remediation goals (PRGs)*** are described in the 300 Area RI/FS report (Section 8.1.4 of DOE/RL-2010-99).

For assessing risks from radionuclides in soil, the residential scenario assumes that exposure to soil within the top 4.6 m (15 ft) occurs over a 30-year period. A residence is established on the waste site and the resident receives exposure from direct contact with the soil from the remediated waste site and through the food chain. This includes potential exposure through external radiation, incidental soil ingestion, and inhalation of ambient dust particulates. The food chain pathway includes exposure from consumption of fruits and vegetables grown in a backyard garden and consumption of meat (beef and poultry) and milk from livestock raised in a pasture. Uptake of contamination into crops and livestock is assumed to occur from contamination present in soil. Contaminants in soil are transported through the soil column, into the underlying groundwater, and to a hypothetical downgradient well located at the waste site boundary that is used for drinking water consumption, irrigation of crops and watering livestock, and creation of a pond to raise fish for consumption. An additional evaluation was performed for groundwater if the only exposure was through use of groundwater as a drinking water source.

Industrial Scenario. This scenario uses the Washington State's MTCA (WAC 173-340) industrial scenario for chemicals and an industrial worker exposure scenario for radionuclides. Each of these scenarios is described below.

For assessing risks from chemicals in soil, MTCA Method C (WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties") levels are used. For direct contact, these levels are based on exposure of an adult from incidental soil ingestion. For the inhalation pathway, MTCA Method C air levels are based on exposure of adults from inhalation of vapors and dust in ambient air. Calculations for the soil PRGs are described in the 300 Area RI/FS report (Section 8.1.4 of DOE/RL-2010-99).

For assessing risks from radionuclides in soil, the industrial worker scenario assumes that exposure to soil within the top 4.6 m (15 ft) occurs 8 hours/day (6 hours indoors and 2 hours outdoors), 250 days/year, over a 25-year period. An adult is assumed to work in a building located on a waste site and to receive exposure by direct contact with soil. This scenario includes potential exposure through external radiation, incidental soil ingestion, and inhalation of ambient dust particulates. Drinking water is assumed to come from an offsite source.

Groundwater. Groundwater contamination within the 300-FF-5 groundwater OU was evaluated using two different methods. Concentrations of chemicals and radionuclides that were measured over the last 5 years were compared to federal and state DWSs. In addition, chemicals were compared to MTCA Method B groundwater cleanup levels. These are the standards and cleanup values established to protect human health. Groundwater ***contaminants of potential concern (COPCs)*** were identified when a concentration was greater than the DWS or MTCA Method B groundwater cleanup levels.

An additional evaluation of human health ELCR and hazards was calculated using EPA's residential drinking water exposure scenario. This scenario assumes that the groundwater is used as a tap water source for a 30-year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. ***Exposure point concentrations (EPCs)*** were used to calculate ELCRs and noncancer hazards. The COPCs were identified when ELCRs and noncancer hazards were greater than thresholds established by EPA and Ecology.

Contaminant Fate and Transport Modeling

Contaminant fate and transport modeling was performed to simulate and predict the movement of uranium from the vadose zone sediments, through the PRZ, and into the saturated zone, as well as the migration of uranium already present in the PRZ and saturated zone. The model predictions indicate a long-term declining trend in the dissolved uranium concentrations in groundwater for uranium transported from vadose zone sediments, with seasonal increases and decreases in concentrations as the water table rises and falls with river-stage fluctuations. With no remedial actions, the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the federal DWS of 30 μg/L. The estimates of the time for the uranium concentration to decline below the DWS for each remedial alternative were based on the longer time of either the 90th percentile, or the 95 percent upper confidence limit on the mean, of the uranium concentration in the most contaminated monitoring well. These fate and transport simulations assume that the current hydrologic and chemical conditions remain unchanged. The two-dimensional model was developed specifically for this evaluation, incorporating data collected since the original modeling was performed to support the 1996 ROD (EPA/ROD/R10-96/143). The model includes more physically based treatment of uranium sorption and desorption processes based on information on uranium transport in this environment gathered from research at DOE's Integrated Field Research Center test site located in the former South Process Pond (316-1).

Transport modeling also was performed for tritium, TCE, and cis-1,2-dichloroethene, which are groundwater contaminants locally present in the aquifer. A fate and transport model was constructed for tritium in the groundwater that exceeds the federal DWS beneath the 618-11 Burial Ground. This analysis determined that the tritium concentrations would decline to below the DWS by 2031 under all alternatives, assuming no additional tritium input to groundwater. Analysis of chemical degradation and transport modeling of organics disposed in the former 300 Area Process Trenches explains the TCE and cis-1,2-dichloroethene concentrations currently observed in groundwater. This analysis is presented in further detail in the 300 Area RI/FS report (Section 5.9 of DOE/RL-2010-99).

Human Health Soil Risks

A total of 70 previously remediated waste sites with closeout verification data from the shallow vadose zone (0 to 4.6 m [0 to 15 ft] below ground surface [bgs]) were evaluated in the risk assessment presented in Chapter 6 of the 300 Area RI/FS report (DOE/RL-2010-99). Four of these previously remediated waste sites (316-1, 316-2, 316-5, and 618-3) contained residual uranium contamination that resulted in an ELCR greater than one in 10,000 (1×10^{-4}) based on the residential exposure scenario. These four waste sites are located within the 300 Area Industrial Complex and result in an ELCR of less than one in 10,000 (1×10^{-4}) based on the industrial exposure scenario. All of the other previously remediated waste sites report a total ELCR less than the MTCA (WAC 173-340-708[5], "Human Health Risk Assessment Procedures") total risk threshold of one in 100,000 (1×10^{-5}) and a ***hazard index*** of less than one for both the residential and industrial exposure scenarios.

The closeout verification data from the deep vadose zone samples collected at four previously remediated waste sites were evaluated to identify where exposure to residual contamination could present a potential risk from an inadvertent exposure through deep excavation activities. Although this contamination is deeper than 4.6 m (15 ft) bgs and there is no current exposure pathway, the PRGs developed for the residential exposure scenario were used to identify where unacceptable exposure could occur if the contamination was brought to the surface. Two previously remediated waste sites (618-1 and 618-2) contained residual radioisotope concentrations that resulted in an ELCR greater than one in 10,000 (1×10^{-4}) based on the residential exposure scenario. Radionuclides associated with historical waste disposal contribute to the majority of the risk and will decay to concentrations less than the residential PRGs within 60 years.

In addition to the residential and industrial risk estimates, the 300 Area RI/FS report (Section 6.2 of DOE/RL-2010-99) also includes an evaluation of the human health risk for the resident national monument worker and the casual recreational user exposure scenarios. These exposure scenarios result in a lower risk than the residential exposure scenario. Tribal exposure scenarios were evaluated in the RCBRA (DOE/RL-2007-21, Volume II) and are summarized in Section 6.1 of the 300 Area RI/FS report. The estimated risk from the Tribal exposure scenarios is higher than the estimated risk for the residential scenario.

The 70 previously remediated waste sites with closeout verification data were also evaluated as potential sources for groundwater and surface water contamination in Chapter 5 of the 300 Area RI/FS report (DOE/RL-2010-99). Five of these waste sites reported residual uranium contamination exceeding the soil PRG for protection of groundwater. The five waste sites are the North Process Pond (316-2); the 300 Area Process Trenches (316-5); and the 618-1, 618-2, and 618-3 Burial Grounds. No other soil contaminants were identified that would cause an unacceptable risk to groundwater or to the Columbia River.

Groundwater Risks

Groundwater was evaluated as a potential drinking water source through a comparison of the EPC for each contaminant against the lowest applicable standard or risk-based concentration, including federal and state DWSs and Washington State's groundwater cleanup levels. To facilitate evaluation, groundwater within the 300-FF-5 OU was separated into two geographic locations: (1) groundwater beneath the 300 Area Industrial Complex, and (2) groundwater beneath the 600 Area subregion.

A total of 54 monitoring wells are completed in the unconfined aquifer within the 300 Area Industrial Complex that were evaluated in the risk assessment. Of these, 15 wells were specifically sampled during the RI to address uncertainties identified in the 300 Area RI/FS sampling and analysis plan (Sections 1.0, 1.2 and 3.5 of DOE/RL-2009-45, *300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2 and 300-FF-5 Operable Units*). The groundwater beneath the 300 Area Industrial Complex contains uranium and nitrate concentrations greater than the federal and state DWSs of 30 µg/L and 45,000 µg/L, respectively. The primary contributor to the nitrate contamination is from offsite sources.

Two VOCs (TCE and cis-1,2-dichloroethene) have also been detected in the 300 Area Industrial Complex at concentrations that exceed both the risk-based concentration (based on the 2007 MTCA Method B groundwater cleanup levels) and the federal and state DWSs. Historically, TCE has exceeded the risk-based cleanup level (4 µg/L) and the DWS (5 µg/L) in a single well (399-4-14). Concentrations from this well ranged between less than 1 to 14 µg/L during the period from 2007 through 2011. During the final sample event for the RI/FS, TCE was also measured above the risk-based level in well 399-4-1 at a concentration of 4.1 µg/L.

Similarly, cis-1,2-dichloroethene has been present above the risk-based cleanup level (16 µg/L) and the DWS (70 µg/L) in two wells (399-1-16B and 399-1-57) in the 300 Area Industrial Complex. Well 399-1-16B was completed in a relatively low-permeability interval that is difficult to monitor because of low recharge rates in this formation. Historical concentrations from this well ranged between 97 to 230 µg/L during the period from 2007 through 2011. During the final sample event for the RI/FS, cis-1,2-dichloroethene was also measured above the risk-based level and DWS in well 399-1-57 at a concentration of 110 µg/L.

A total of 17 monitoring wells are completed in the unconfined aquifer within the 600 Area subregion and were evaluated in the risk assessment. All of these wells were specifically sampled during the RI to address uncertainties identified in the 300 Area RI/FS sampling and analysis plan (Sections 1.0, 1.2 and 3.5 of DOE/RL-2009-45). Groundwater beneath the 600 Area subregion received releases from the 618-7, 618-10, and 618-11 Burial Grounds and the 316-4 Crib. Tritium and nitrate concentrations downgradient from the 618-11 Burial Ground are greater than the federal and state DWSs. Tritium concentrations are predicted to decline below the DWSs by 2031 based on the results of fate and transport modeling. Downgradient of the 618-7 Burial Ground, total chromium concentrations in a single well and uranium concentrations in two wells have exceeded the federal and state DWSs. This groundwater contamination is attributed to the use of dust-suppression water during remediation of the 618-7 Burial Ground. Since remediation of this waste site has been completed, the groundwater concentrations have declined below the DWSs. Similarly, uranium concentrations downgradient from the 618-10 Burial Ground have exceeded federal and state DWSs. These elevated concentrations are also attributed to the use of dust-suppression water during remediation of the 316-4 Crib and 618-10 Burial Ground.

Contaminant concentrations in the groundwater were also compared to surface water standards for protection of human health and aquatic organisms because of groundwater discharges to the Columbia River. This comparison included Washington State surface water quality standards for fresh water and federal ambient water quality criteria. All groundwater contaminant concentrations were lower than these standards and criteria.

Based on the results of the groundwater risk evaluation, concentrations of uranium, TCE, cis-1,2-dichloroethene, and nitrate in the 300 Area Industrial Complex, and tritium and nitrate in the 600 Area subregion, are present at levels that exceed DWSs and are identified as COCs.

Ecological Risks at Upland Areas

The RCBRA (DOE/RL-2007-21, Volume I) and the 300 Area RI/FS report (Chapter 7 of DOE/RL-2010-99) evaluated ecological risks at 300 Area interim remediated waste sites with upland habitats for potential ecological risks. The 300 Area RI/FS used information from the RCBRA and from other sources to evaluate the risk to populations and communities of ecological receptors, and it was concluded that there was no ecological risk at remediated waste sites within the 300-FF-1 and 300-FF-2 OUs. The ecological risk evaluations have identified that interim remedial actions that have achieved interim action ROD cleanup levels to protect human health will also protect ecological receptors, particularly when the sizes of remedial actions are considered relative to ecological receptor home ranges. Once human health cleanup levels are achieved, residual contamination would not be sufficient to adversely impact populations and communities of ecological receptors.

Ecological Risks at Riparian and Near-Shore Areas

The RCBRA (DOE/RL-2007-21, Volume I), the CRC (DOE/RL-2010-117, Volume I), and the 300 Area RI/FS report (Section 7.5 of DOE/RL-2010-99) evaluated ecological risks present in the riparian, near-shore, and river areas adjacent to the 300 Area. The 300 Area RI/FS used information from these risk assessments and from other sources to evaluate risk to populations and communities of ecological receptors. The RI/FS evaluated contaminants present in these environments and pathways where Hanford Site operations may have released contaminants to the riparian, near-shore, and river environments. The evaluation included releases or potential releases of uranium, TCE, and cis-1,2-dichloroethene into the river from groundwater. The RI/FS concluded that there were no contaminants of ecological concern and, therefore, no ecological risk from Hanford that were at levels that warranted remedial action.

Contaminants of Concern

The COCs are radionuclides and chemicals that pose an unacceptable threat to HHE and, therefore, need to be addressed by a remedial action. COCs are typically contaminants that exceed an acceptable risk level or a federal or state standard.

The vadose zone COCs for the 300-FF-1 and 300-FF-2 OUs are based on the evaluation of closeout verification soil data for remediated waste sites and soil samples collected for the 300 Area RI/FS. The vadose zone COCs for the 300-FF-1 and 300-FF-2 OUs are evaluated and identified in Chapter 5 of the 300 Area RI/FS report addendum (DOE/RL-2010-99-ADD1). The vadose zone principal risk driver COCs are uranium (including uranium isotopes uranium-233/234, uranium-235, and uranium-238), cesium-137, cobalt-60, strontium-90, and polychlorinated biphenyls (Table 1). The vadose zone COCs listed in Table 1 apply to all of the waste sites included in this Proposed Plan for the 300-FF-1 and 300-FF-2 OUs and are considered the principal risk driver COCs for these OUs.

Table 1. Vadose Zone Principal Risk Driver COCs for the 300-FF-1 and 300-FF-2 OUs

Radionuclides	Metals	Polychlorinated Biphenyl Aroclors
Cesium-137	Uranium (total)	Aroclor 1016
Cobalt-60		Aroclor 1221
Strontium-90		Aroclor 1232
Uranium-233/234		Aroclor 1254
Uranium-235		Aroclor 1260
Uranium-238		Aroclor 1016
		Aroclor 1254

Source: Table 5-1 in DOE/RL-2010-99-ADD1, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units, Addendum*.

The groundwater COCs for the 300-FF-5 OU are based on evaluation of groundwater data. The groundwater COCs for the 300-FF-5 OU are evaluated and identified in the 300 Area RI/FS report (Section 6.5 of DOE/RL-2010-99). The groundwater COCs are uranium, gross alpha, tritium, nitrate, TCE, and cis-1,2-dichloroethene (Table 2). Most of the gross alpha is produced by radioactive decay of uranium. Several other metals and VOCs that have occasionally been detected in groundwater above standards are not included as COCs but are identified in Section 6.5 of the 300 Area RI/FS report.

Table 2. Groundwater COCs for the 300-FF-5 OU

Radionuclides	Metals	Volatile Organics
Tritium	Uranium	cis-1,2-Dichloroethene
Gross alpha	**Inorganic Anions**	Trichloroethene
	Nitrate	

Notes: COCs were detected at concentrations in groundwater higher than drinking water standards or risk thresholds. (Source: Section 6.5 of DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*).

The contaminants of concern do not include groundwater contaminants that occasionally were detected above drinking water standards.

Need for Action

A total of 70 previously remediated waste sites with closeout verification data were evaluated in the 300 Area RI/FS. Four of these waste sites reported risks greater than one in 10,000 (1×10^{-4}) based on the residential exposure scenario, but the sites reported risks less than one in 10,000 (1×10^{-4}) based on the industrial exposure scenario. These four waste sites are located within the 300 Area Industrial Complex and include the South Process Pond (316-1), North Process Pond (316-2), the 300 Area Process Trenches (316-5), and the 618-3 Burial Ground.

Five of the previously remediated waste sites reported uranium concentrations exceeding the soil PRGs for protection of groundwater. These five waste sites are located within the 300 Area Industrial Complex and include the North Process Pond (316-2); the 300 Area Process Trenches (316-5); and the 618-1, 618-2, and 618-3 Burial Grounds. In addition, the South Process Pond (316-1) did not exceed the soil PRGs for protection of groundwater, but it is considered a uranium source for groundwater contamination due to the large disposal inventory and the proximity of the waste site to higher groundwater contamination.

Waste sites that have not been remediated were evaluated and were determined to pose an unacceptable risk to HHE from direct exposure. Some of the waste sites are potential sources for groundwater contamination, thus providing the basis for remedial action.

Based on the results of the groundwater risk evaluation, concentrations of uranium, TCE, cis-1,2-dichloroethene, and nitrate in the 300 Area Industrial Complex, and tritium and nitrate in the 600 Area subregion, are present at levels that provide the basis for remedial action.

It is the current judgment of DOE and EPA that the preferred alternative identified in this Proposed Plan, or one of the other active measures considered in this Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, and contaminants into the environment that may present an imminent and substantial endangerment to public health or welfare.

Introduction → Site Background → Site Characteristics → Scope and Role → Summary of Site Risks → Remedial Action Objectives → Summary of Remedial Alternatives → Evaluation of Remedial Alternatives → Preferred Remedial Alternative → Community Participation

Remedial Action Objectives

The RAOs describe what a proposed remedial action is expected to accomplish. Along with RAOs, PRGs are developed during the RI/FS and are used to evaluate remedial alternatives. The PRGs presented in this Proposed Plan are the proposed cleanup levels for the ROD. The RAOs typically include information on the media, receptors, and contaminants, taking into account the reasonably anticipated future land use. DOE and EPA have agreed to proceed with cleanup levels that are based on industrial and residential scenarios. Remediation of the 300 Area Industrial Complex and the 618-11 Burial Ground will be based on industrial scenarios, and the remainder of the 300 Area (outside the 300 Area Industrial Complex and 618-11 Burial Ground) will be based on residential scenarios (Figure 13). Therefore, both the residential and industrial scenarios were used for the preparation of the following RAOs:

- **RAO #1:** Prevent human exposure to groundwater containing COC concentrations above PRGs.
- **RAO #2:** Prevent COCs migrating and/or leaching through soil that will result in groundwater concentrations above PRGs for protection of groundwater, and of surface water at locations where groundwater discharges to surface water.
- **RAO #3:** Prevent human exposure to the upper 4.6 m (15 ft) of soil and structures and ***debris*** contaminated with COCs at concentrations above PRGs for residential use in areas outside both the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- **RAO #4:** Prevent human exposure to the upper 4.6 m (15 ft) of soil and structures and debris contaminated with COCs at concentrations above PRGs for industrial use in the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- **RAO #5:** Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to HHE.

- **RAO #6:** Prevent ecological receptors from direct exposure to the upper 4.6 m (15 ft) of soil and structures and debris contaminated with COCs at concentrations above PRGs.
- **RAO #7:** Restore groundwater impacted by Hanford Site releases to PRGs within a time frame that is reasonable given the particular circumstances of the site.

These RAOs are protective of HHE and are compatible with the RAOs stated in the two previous RODs.

Preliminary Remediation Goals

The PRGs provide the basis for cleanup levels in the ROD. PRGs are based on the RAOs and establish acceptable exposure levels for specific contaminants based on the media (e.g., soil or groundwater) and exposure scenario (e.g., residential activities).

Soil PRGs for direct contact human health and for ecological receptors were developed using standard approaches, consistent with state and federal guidance. Direct contact PRGs for nonradionuclides are based on risk calculations provided in the Washington State's MTCA procedures using either health hazard thresholds or a 1 in 1,000,000 ELCR. Direct contact PRGs for radionuclides are calculated based on radionuclide dose (15 mrem/year) and on ELCRs (1 in 10,000 risk). For each radionuclide, the lower of the dose or risk-based calculations is proposed for use for cleanup.

Soil PRGs for groundwater and surface water protection were also developed based on current state and federal guidance and, consistent with guidance, incorporated site-specific data from the 300 Area. For the 300 Area, soil PRGs are presented based on residential scenarios with irrigation and based on an industrial scenario without irrigation. One main difference between the scenarios is the amount of water infiltrating the soil to reach groundwater. The industrial scenario is based on natural precipitation, no irrigation, runoff management from surfaces such as pavement, and marginal vegetation cover. The industrial scenario assumes that a moderate 25 mm/year of precipitation reaches groundwater. In residential areas, irrigation provides an increased amount of water to the soil, and a relatively high 72 mm/year of water reaches groundwater.

The irrigated residential scenario (Section 5.7.2 in the 300 Area RI/FS report [DOE/RL-2010-99]) is used to identify the potential for groundwater and surface water contamination to occur from waste sites due to higher groundwater recharge rates associated with the irrigation of crops. This irrigated residential scenario was used to develop the irrigation PRGs (Section 2.1 of the 300 Area RI/FS report addendum [DOE/RL-2010-99-ADD1]).

The PRGs developed in the RI/FS are proposed as cleanup levels for all alternatives in the ROD. Residential PRGs for areas outside of the 300 Area Industrial Complex and the 618-11 Burial Ground, and industrial PRGs for areas inside the 300 Area Industrial Complex and the 618-11 Burial Ground for waste sites, are presented in Appendix A of this Proposed Plan (Table A-1). PRGs for groundwater are presented in Table A-2. These PRGs have been updated using toxicity values published by EPA in November 2012 (Chapter 2 of the 300 Area RI/FS report addendum [DOE/RL-2010-99-ADD1]).

PRGs are calculated for single contaminants. During the cleanup verification process for individual waste sites, cleanup levels will be adjusted to account for waste site-specific residual contamination information. For sites with multiple residual contaminants, risks from individual contaminants will be added and evaluated to ensure that the waste site meets total risk limits as specified in CERCLA, the NCP, and MTCA. When a groundwater protection cleanup level is exceeded, site-specific information will be evaluated to determine if remediation has achieved the RAOs.

Summary of Remedial Alternatives

Remedial alternatives were developed in the 300 Area RI/FS report (Chapter 9 of DOE/RL-2010-99) and the 300 Area RI/FS report addendum (Chapter 6 of DOE/RL-2010-99-ADD1) based on the results of a detailed technology screening. Several technologies that are typically used at Hanford for groundwater remediation were not retained. For example, reactive chemical barriers were not retained as a potential technology for treating uranium in groundwater because these technologies were not considered as effective or permanent compared to direct uranium sequestration using phosphate. In addition, pump-and-treat technology was also not retained for uranium treatment because the majority of the uranium (greater than 95 percent) is found in the vadose zone and PRZ rather than in the groundwater. Chapter 8 and Appendix J of the 300 Area RI/FS report (DOE/RL-2010-99) present a complete discussion on these technologies and rationale regarding why they were not retained for detailed and comparative analysis.

The following alternatives include a range of technology groupings that address soil and groundwater, collectively:

- **Alternative 1:** No Action
- **Alternative 2:** RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs
- **Alternative 3:** RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs
- **Alternative 3a (Preferred Alternative):** RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs
- **Alternative 4:** RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs
- **Alternative 5:** RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Common Elements

Remedial action alternatives developed for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs have some common components. These common elements are discussed below.

Institutional Controls. Alternatives 2, 3, 3a, 4, and 5 require ICs before, during, and after the active phase of remedial action implementation where ICs are required to protect HHE. DOE is responsible for implementing, maintaining, reporting, and enforcing ICs for the Hanford Site and for current CERCLA response actions. The Sitewide IC plan (DOE/RL-2001-41) describes how ICs are implemented and maintained, and how they would be modified to incorporate additional requirements upon selection of future remedies that include ICs. The ICs to be implemented by DOE to support achievement of the RAOs include the following:

- Signage and access control to waste sites
- Maintenance and operation of an excavation permit program for protection of environmental and cultural resources and site workers

- Administrative controls limiting groundwater access and use where groundwater is above DWSs
- Deed and zoning restrictions (in the event of land transfer out of federal ownership)
- Control excavation in areas where contamination remains deeper than 4.6 m (15 ft) bgs exceeding levels protective of HHE
- Prevent enhanced recharge over or near waste sites with potential to pose an unacceptable groundwater risk from irrigation
- Prevent bare gravel or bare sand covers over waste sites in the 300 Area Industrial Complex
- Prevent enhanced recharge from the discharge of water (e.g., drainage from paved parking lots or buildings) on or near waste sites in the 300 Area Industrial Complex
- Prevent landscape watering over or near waste sites in the 300 Area Industrial Complex

Removal, Treatment, and Disposal at Waste Sites. RTD of waste sites in Alternatives 2, 3, 3a, 4, and 5 is a continuation of RTD from the 300-FF-2 OU interim action ROD (EPA/ROD/R10-01/119), with PRGs updated to those presented in this Proposed Plan. Consistent with this, these alternatives would achieve RAOs through (1) RTD of the soil as deep as 4.6 m (15 ft) in waste sites to protect human health and ecological receptors from direct exposure to contaminants, (2) removal of engineered structures (e.g., burial ground trenches), (3) RTD of the soil below 4.6 m (15 ft) for contaminants other than uranium in waste sites to protect groundwater quality and Columbia River water quality, and (4) backfill and revegetation of the excavated waste sites. Consistent with future land use, irrigation would be restricted in the areas identified for industrial cleanup. ICs would also be applied to waste sites outside of the industrial cleanup that have contamination deeper than 4.6 m (15 ft) bgs exceeding the PRGs based on residential exposure scenarios. Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated, but ICs are included to ensure that future activities do not inadvertently bring this contamination to the surface.

Consistent with the RTD described above, contaminated soil and debris with concentrations above PRGs would be removed from the waste sites, treated as necessary to meet disposal facility requirements, and sent to ERDF (which is considered onsite) or another facility approved by EPA. The RTD activities allow treatment to precede removal (e.g., for highly radioactive material, including principal threat waste) to control worker exposure and minimize airborne releases.

Soil from waste site 300-296 below the 324 Building radiochemical engineering cell (cell B) is proposed to be removed as part of 300-FF-2 OU remediation. The highly contaminated soil will be immobilized and placed into cells C and D of the 324 Building radiochemical engineering cell, which provide additional shielding to workers from radioactive contaminants. Removal of the 324 Building (and the radiochemical engineering cells that would contain this 300-296 waste) will be performed under CERCLA Action Memorandum #2 for the 300 Area Facilities (DOE and EPA, 2006a). In addition, removal of the TSD units in the 324 Building radiochemical engineering cells will be performed under the RCRA closure plan (DOE/RL-96-73).

Contaminated soil around pipelines in the 300 Area will be remediated to meet PRGs for direct contact and for groundwater and surface water protection PRGs, as described above. In addition, the process sewer system that transported contaminated liquids from the operations facilities to the liquid waste disposal facilities (waste site 300-15) that is above 3 m (10 ft) deep will be removed regardless of contamination.

Temporary Surface Barriers and Pipeline Void Filling. For waste sites that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities), temporary surface caps will be installed to minimize recharge and contaminant flux to groundwater (Figure 10). The design of the caps will be described in the remedial design report/remedial action work plan (RDR/RAWP). Surface caps will be constructed of asphalt and may contain other materials to decrease permeability and increase durability (e.g., high-density polyethylene and soil cover). In addition, pipelines inaccessible for the RTD remedy due to their close proximity to long-term facilities will be void filled to immobilize uranium (and elemental mercury in waste site 300 Retired Radioactive Liquid Waste Sewer) in pipelines for groundwater protection. When the long-term facilities are no longer in use and are removed, the waste sites and pipelines will be remediated as described above in the RTD discussion. The long-term facilities are shown on Figure 1-9 in the 300 Area RI/FS report (DOE/RL-2010-99).

Monitored Natural Attenuation for Groundwater. MNA is a remedial strategy that monitors natural attenuation processes until RAOs are met, provided that the RAOs are met within a reasonable time frame. Natural attenuation relies on natural processes within the aquifer to achieve reductions in the TMV, concentration, and/or bioavailability of contaminants. These natural processes include physical, chemical, and biological transformations that occur without human intervention. Contaminants in groundwater that will be managed through MNA include tritium downgradient from the 618-11 Burial Ground, and TCE and cis-1,2-dichloroethene at the 300 Area Industrial Complex.

MNA is the proposed action for the tritium in groundwater beneath the 618-11 Burial Ground. Natural attenuation will occur through a combination of natural radiological decay and dispersion during transport. Computer modeling predicts that the tritium concentrations will decrease to below the DWS by 2031. The waste within the 618-11 Burial Ground that released the tritium will be removed by RTD.

MNA is the proposed action for the TCE and cis-1,2-dichloroethene at the 300 Area Industrial Complex. Natural attenuation will occur primarily through physical attenuation (diffusion and dispersion) and biodegradation. TCE and cis-1,2-dichloroethene contamination exceeding PRGs is restricted to fine-grained sediment with negligible capacity to yield or transmit groundwater. Greatly restricted hydraulic flow has contained the VOCs in the fine-grained sediment since their disposal decades ago and has minimized migration of VOCs into the more transmissive portions of the aquifer. Concentrations of these VOCs are not above PRGs in this more transmissive portion of the aquifer that discharges to the Columbia River. Attenuation through biodegradation is evident in historical monitoring results from well 399-1-16B, where TCE has degraded to cis-1,2-dichloroethene. Over the past 20 years, TCE concentrations from this well have decreased to below the DWS, whereas cis-1,2-dichloroethene concentrations have remained fairly stable. Cis-1,2-dichloroethene can then further degrade anaerobically to vinyl chloride, which then degrades either anaerobically or aerobically to carbon dioxide. Cis-1,2-dichloroethene can also degrade directly to carbon dioxide under aerobic conditions. The absence of cis-1,2-dichloroethene and vinyl chloride in downgradient wells indicates that these contaminants are degrading aerobically as they slowly diffuse into the more aerobic zones of the aquifer. The limited areal extent of VOCs in groundwater shows that these attenuation processes are working to prevent significant migration of VOCs.

Groundwater Monitoring. In addition to MNA, groundwater monitoring will be performed to evaluate the effectiveness of the selected alternative to achieve RAOs. Monitoring will be performed for groundwater COCs (uranium, gross alpha, nitrate, TCE, and cis-1,2-dichloroethene at the 300 Area Industrial Complex; uranium and gross alpha downgradient from the 618-7 Burial Ground; and tritium and nitrate downgradient from the 618-11 Burial Ground).

Transition from Interim to Final Action. Until the RDR/RAWP for the ROD associated with this Proposed Plan is approved, any ongoing RTD will continue in accordance with the interim action ROD. After this ROD is approved, the existing interim action RDR/RAWP will be revised to adopt the new cleanup levels. In addition, DOE will develop and submit, for EPA approval, a new RDR/RAWP and groundwater monitoring plan prepared in accordance with the Tri-Party Agreement (Ecology et al., 1989) for the final remedy selected. All future remedial actions will then be performed under the approved RDR/RAWP.

Alternative 1 — No Action

> ***Estimated capital cost:*** *$0 million*
>
> ***Estimated O&M cost:*** *$0 million*
>
> ***Estimated present value (discounted):*** *$0 million*

Consideration of a No Action alternative is a requirement of the NCP (40 CFR 300.430[e][6]) and is included to provide a baseline for comparison against the other alternatives. Under the No Action alternative, no active remedial action would be taken to address potential threats to HHE posed by the COCs present. All ongoing actions would cease, including interim actions, ICs, and groundwater monitoring. The No Action alternative would not remediate the waste sites and, as a result, these waste sites would have residual contamination that is not protective of HHE. Groundwater restoration for the uranium contamination in the 300 Area Industrial Complex would only occur through natural processes.

Alternative 2 — RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

> ***Estimated capital cost:*** *$245 million*
>
> ***Estimated O&M cost:*** *$40 million*
>
> ***Estimated present value (discounted):*** *$233 million*
>
> ***Estimated time to achieve PRGs for uranium in groundwater:*** *28 years*
>
> ***Estimated time to achieve PRGs for tritium in groundwater:*** *18 years*
>
> ***Estimated time to achieve PRGs by RTD for waste sites:*** *19 years*

Alternative 2 uses a combination of RTD at waste sites in the 300-FF-2 OU; MNA for tritium, TCE, and cis-1,2-dichloroethene in groundwater; monitoring for uranium, gross alpha, and nitrate in groundwater; and ICs. Remedial technologies for Alternative 2 are discussed in the "Common Elements" section of this Proposed Plan and are shown on Figure 14.

It is estimated that it will take approximately 28 years (by 2041) for the uranium concentrations in groundwater to decrease below the DWS if Alternative 2 is implemented. Alternative 2 does not modify the remedy previously selected for the 300-FF-1 OU in the applicable ROD. No further remedial action will be performed for the residual uranium contamination associated with the 300-FF-1 OU waste sites.

There is significant uncertainty in the estimated time to achieve the uranium DWS described in the modeling section of the 300 Area RI/FS report (Chapter 5 and Appendix F of DOE/RL-2010-99). The estimated times to achieve the uranium DWS in groundwater for all of the alternatives depends primarily on the magnitude of river-stage fluctuations, which may differ from the magnitudes assumed in the model. The uncertainty in the estimated time to achieve the uranium DWS in the groundwater is the highest for Alternative 2, which depends primarily on the magnitude of future river-stage fluctuations and does not benefit from any remedial actions that reduce the amount of uranium in the deep vadose zone and PRZ.

Alternative 2: RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

The RTD component in Alternative 2 will replace the RTD component of the 300-FF-2 OU Interim Action ROD (EPA/ROD/R10-01/119). The RTD component in Alternative 2 incorporates the 300-FF-2 OU Interim Action ROD requirements to RTD the waste sites to protect human health from direct exposure as deep as 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites as deep as 4.6 m (15 ft) bgs to protect human health from direct exposure, and for the protection of groundwater and the Columbia River throughout the entire soil column. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

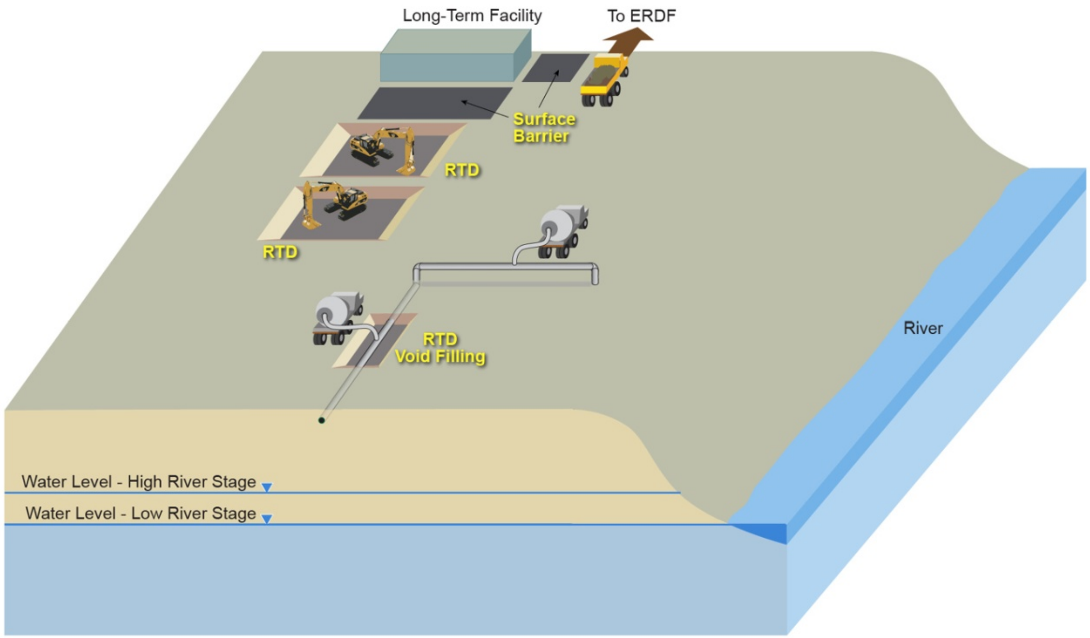
Groundwater

Alternative 2 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring for uranium, gross alpha, and nitrate.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Monitoring	TOTAL
Total Present Value of Alternative (Discounted)	$ 229,751,000	$ 3,260,000	$ 233,011,000

Note: Waste site treatment costs include the costs for institutional controls.

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Figure 14. Alternative 2 — RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Alternative 3 — RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Estimated capital cost: *$280 million*

Estimated O&M cost: *$144 million*

Estimated present value (discounted): *$367 million*

Estimated time to achieve PRGs for uranium in groundwater: *22 years*

Estimated time to achieve PRGs for tritium in groundwater: *18 years*

Estimated time to achieve PRGs by RTD for waste sites: *19 years*

Alternative 3 uses a combination of RTD at waste sites in the 300-FF-2 OU; phased approach for implementation of uranium sequestration in the vadose zone, PRZ, and top of the aquifer at the treatment zone; MNA for tritium, TCE, and cis-1,2-dichloroethene in groundwater; monitoring for uranium, gross alpha, and nitrate in groundwater; and ICs. Compared to the No Action alternative, this alternative reduces the time to restore the uranium-contaminated groundwater to the DWS in the 300 Area Industrial Complex because it addresses the continuing source of uranium in the PRZ.

Alternative 3 involves uranium sequestration in the vadose zone, PRZ, and top of the aquifer at the treatment zone, in addition to the remedial components identified in the "Common Elements" section of this Proposed Plan. All remedial components for Alternative 3 are shown on Figure 15. In this alternative, phosphate solution is added to the vadose zone, PRZ, and top of the aquifer at the treatment zone to sequester, or bind, residual uranium to form a stable and insoluble mineral called autunite. This is anticipated to result in a reduction of soluble uranium entering the groundwater and is anticipated to reduce the restoration time frame for uranium in the groundwater.

The application of phosphate to sequester residual uranium will target the areas of highest contribution of uranium to groundwater from the deep vadose zone and PRZ, as described in the conceptual model in the 300 Area RI/FS report (Section 4.8.3 of DOE/RL-2010-99). Previous tests performed in the laboratory and in groundwater demonstrated that the uranium sequestration technology is viable (described in Section 9.2.4.1 of the 30 Area RI/FS report [DOE/RL-2010-99]). However, tests performed to date for groundwater and the vadose zone have not provided sufficient information to optimize implementation of this technology on a large scale. Therefore, a phased approach will be used to collect the necessary design information (Phase I) that will be used for full-scale remedy implementation (Phase II), if needed, to meet groundwater restoration goals in a reasonable time frame. This approach is consistent with recommendations for phased implementation provided in EPA guidance for this type of complex groundwater contamination (EPA 540-R-98-031, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, Appendix B.1).

Phase I will apply phosphate to the highest uranium concentration areas of the vadose zone and PRZ using a combination of surface infiltration, PRZ injection, and groundwater injection techniques. Phase I will be applied over an area of approximately 1 ha (3 ac). Prior to phosphate application in the vadose zone and PRZ, phosphate will be injected into the upper portion of the groundwater to attempt to sequester, or bind, uranium potentially mobilized by the surface infiltration and PRZ injection. Following phosphate additions, vadose zone core samples will be collected to assess changes in uranium mobility, and groundwater monitoring will be conducted to assess changes in uranium concentrations. Design details of the application approach illustrated in Figure 16 will be further defined in the RDR/RAWP to be prepared after the ROD associated with this Proposed Plan is issued.

Alternative 3: RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of Aquifer; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

The RTD component in Alternative 3 will replace the RTD component of the 300-FF-2 OU Interim Action ROD (EPA/ROD/R10-01/119). The RTD component in Alternative 3 incorporates the 300-FF-2 OU Interim Action ROD requirements to RTD the waste sites to protect human health from direct exposure as deep as 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites as deep as 4.6 m (15 ft) bgs to protect human health from direct exposure, and for the protection of groundwater and the Columbia River throughout the entire soil column. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Phased approach uranium sequestration in the vadose zone and PRZ using a combination of surface infiltration and deep injection techniques into the PRZ for the waste sites with uranium contamination deeper than 4.6 m (15 ft) bgs.
- Phased approach uranium sequestration at the top of the aquifer below the treatment zone to remediate any untreated uranium mobilized from the vadose zone during surface infiltration and injection into the PRZ.
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

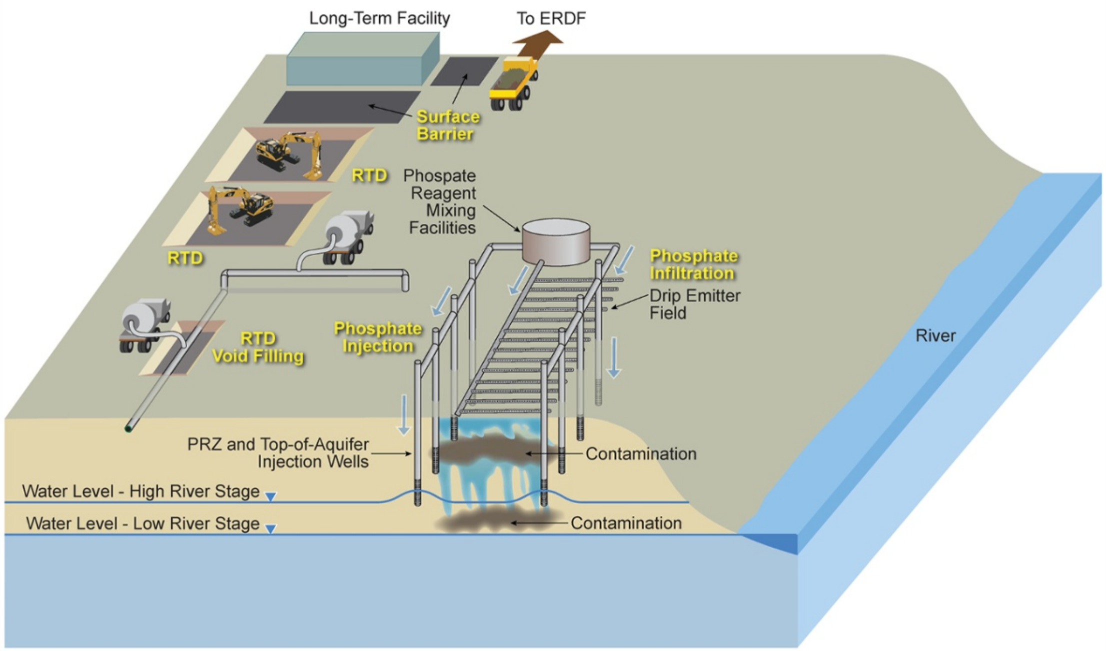
Groundwater

Alternative 3 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring for uranium, gross alpha, and nitrate.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Monitoring	TOTAL
Total Present Value of Alternative (Discounted)	$ 355,359,000	$ 11,480,000	$ 366,839,000

Note: Waste site treatment costs include the costs for institutional controls.

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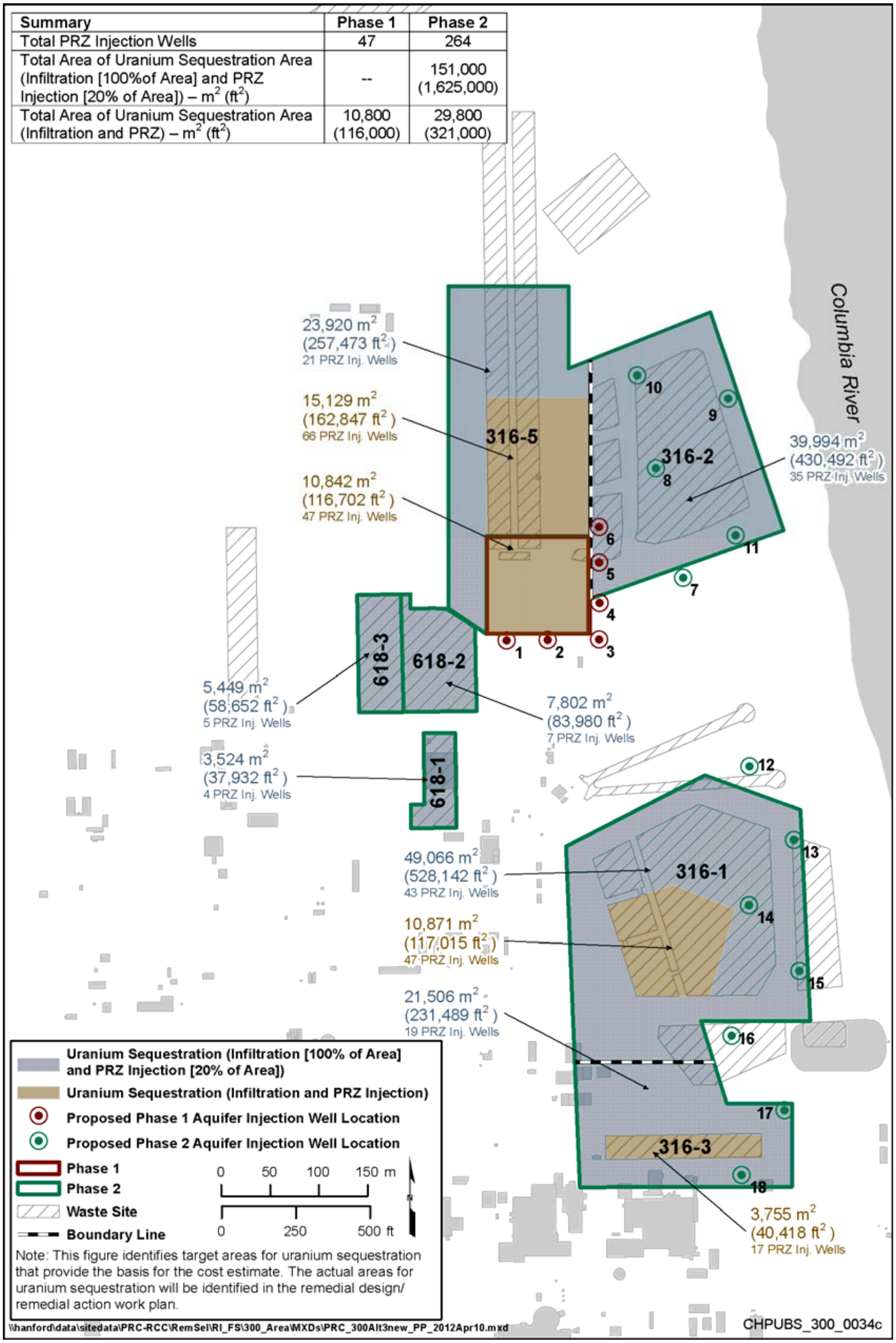
Figure 15. Alternative 3 — RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs



Summary	Phase 1	Phase 2
Total PRZ Injection Wells	47	264
Total Area of Uranium Sequestration Area (Infiltration [100%of Area] and PRZ Injection [20% of Area]) – m^2 (ft^2)	--	151,000 (1,625,000)
Total Area of Uranium Sequestration Area (Infiltration and PRZ) – m^2 (ft^2)	10,800 (116,000)	29,800 (321,000)

Figure 16. Areas for Uranium Sequestration (Alternative 3)

The following conditions must be met at the conclusion of Phase I in order for Phase II to begin:

- Laboratory tests of pre-treatment cores will need to show that an excess of 50 years of high water cycles, allowing the water to rise and fall in the PRZ, are required to achieve DWSs.
- Vadose zone core sample data and the groundwater response from Phase I testing will need to demonstrate the efficacy of the treatment approach to deliver treatment solutions to the PRZ.
- Laboratory testing of post-treatment vadose zone core samples and the groundwater response from Phase I testing will need to demonstrate that the technology provides adequate treatment to significantly improve the time to achieve DWSs within 50 years.

If all three of these conditions are met, Phase II will be initiated. Phase II is an expansion of Phase I to approximately 18 ha (45 ac) (Figure 16).

Phase I and Phase II of the remedial action are estimated to take approximately 6 years to complete. This time period is based on one year to complete the RDR/RAWP, 3 years to implement and evaluate Phase I sequestration, and, if required, an additional 2 years to implement Phase II sequestration. Following completion of these remedial actions, the model predicts that the DWS for uranium would be achieved in 16 years. Therefore, the overall time for Alternative 3 to achieve the uranium DWS is approximately 22 years.

There is uncertainty regarding the estimated time to achieve the uranium DWS in Alternative 3. This uncertainty is described in the modeling section of the 300 Area RI/FS report (Chapter 5 and Appendix F of DOE/RL-2010-99). This uncertainty is due to complex interactions of the contamination in the vadose zone, PRZ, and groundwater with the dynamic groundwater levels controlled by seasonal elevation changes in the river water. Alternative 3 minimizes these impacts by providing partial treatment of the groundwater to sequester uranium mobilized through the application of phosphate to the overlying vadose zone and PRZ. Phosphate application will be performed when groundwater velocities are slow. Although Alternative 3 is estimated to achieve the uranium DWS within 22 years, this time frame is highly uncertain due to the factors described above.

Alternative 3a — RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs (Preferred Alternative)

Estimated capital cost: *$254 million*

Estimated O&M cost: *$44 million*

Estimated present value (discounted): *$259 million*

Estimated time to achieve PRGs for uranium in groundwater: *22 to 28 years*

Estimated time to achieve PRGs for tritium in groundwater: *18 years*

Estimated time to achieve PRGs by RTD for waste sites: *19 years*

Alternative 3a uses a combination of RTD at waste sites in the 300-FF-2 OU; enhanced attenuation by applying reagents to a portion of the deep uranium contamination in the vadose zone and PRZ; MNA for tritium, TCE, and cis-1,2-dichloroethene in groundwater; and monitoring for uranium, gross alpha, and nitrate in groundwater. ICs are used to control access to residual contaminants in soil and groundwater as long as they exceed the cleanup levels as established in the ROD associated with this Proposed Plan. This alternative is anticipated to reduce the time, as compared to the No Action alternative, to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the highest continuing source of uranium in the PRZ.

Alternative 3a uses enhanced attenuation for uranium in the deep vadose zone and PRZ, in addition to the remedial components identified in the "Common Elements" section of this Proposed Plan. Similar to Alternative 3, phosphate solution is added to the vadose zone, PRZ, and top of the aquifer at the treatment zone to sequester residual uranium to form a stable and insoluble mineral called autunite. This is anticipated to result in a reduction of soluble uranium entering the groundwater, and it is anticipated to reduce the restoration time frame for uranium in the groundwater. All remedial technologies for Alternative 3a are shown on Figure 17. The unique characteristics of Alternative 3a include the following:

- Groundwater monitoring for uranium at waste sites in the 300-FF-1 OU and 300-FF-2 OU with uranium contamination above PRGs deeper than 4.6 m (15 ft) bgs (former liquid waste sites 316-1, 316-2, 316-3, and 316-5; and former solid waste sites 618-1, 618-2, and 618-3).
- The enhanced attenuation of residual uranium in the deep vadose zone and PRZ will occur in an area of approximately 1 ha (3 ac) that is contributing to the persistent uranium groundwater contamination in the vicinity of former waste sites 316-5 and 316-2. This is the location where the highest uranium contamination consistently occurs in groundwater.

This alternative will apply phosphate to the highest uranium concentration areas of the vadose zone and PRZ using a combination of surface infiltration, PRZ injection, and groundwater injection techniques. Prior to phosphate application in the vadose zone and PRZ, phosphate will be injected into the upper portion of the groundwater to attempt to sequester uranium potentially mobilized by the surface infiltration and PRZ injection. During implementation, tests will be conducted on post-treatment vadose zone core samples to refine the groundwater model, and groundwater monitoring will be conducted to assess changes in uranium concentrations and the lateral spread of phosphate. Design details of the application approach consistent with Figure 18 will be identified in the RDR/RAWP to be prepared after the ROD associated with this Proposed Plan is issued.

The enhanced attenuation remedy is supported by EPA in its directive on MNA (EPA/540/R-99/009, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*), which includes the following statement: "…by definition, a remedy that includes the introduction of an enhancer of any type is no longer considered to be 'natural' attenuation." Sustainable enhanced attenuation processes, when added to the remediation treatment train, may result in an increase in attenuation capacity sufficient for meeting the remediation goal. The use of sequestration as an enhancement to immobilize the deep residual uranium that is providing the highest uranium concentrations to the groundwater will accelerate the natural attenuation of uranium contamination in the vadose zone, PRZ, and aquifer.

With Alternative 3a, approximately 4 years are anticipated to complete the remedial action. This time period is based on one year to complete the RDR/RAWP and 3 years to implement the enhanced attenuation. This alternative addresses the deep uranium contamination contributing to the persistent groundwater contamination in the vicinity of former waste sites 316-5 and 316-2; therefore, the estimated time to achieve the groundwater DWS for uranium is expected to range between Alternative 3 (22 years) and Alternative 2 (28 years).

Uncertainty exists in the estimated time to achieve the uranium DWS in Alternative 3a. This uncertainty is described in the modeling section of the 300 Area RI/FS report (Chapter 5 and Appendix F of DOE/RL-2010-99). This uncertainty is due to complex interactions of the contamination in the vadose zone, PRZ, and groundwater with the dynamic groundwater levels controlled by seasonal changes in the elevation of the river water. Alternative 3a minimizes these impacts by providing partial treatment of the groundwater to sequester uranium mobilized through the application of phosphate to the overlying vadose zone and PRZ. Phosphate application will be performed when groundwater velocities are slow. Although Alternative 3a is estimated to achieve the uranium DWS in 22 to 28 years, this time frame is highly uncertain due to the factors described above.

Alternative 3a: RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

The RTD component in Alternative 3a will replace the RTD component of the 300-FF-2 OU Interim Action ROD (EPA/ROD/R10-01/119). The RTD component in Alternative 3a incorporates the 300-FF-2 OU Interim Action ROD requirements to RTD the waste sites to protect human health from direct exposure as deep as 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites as deep as 4.6 m (15 ft) bgs to protect human health from direct exposure, and for the protection of groundwater and the Columbia River throughout the entire soil column. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Enhanced attenuation with sequestration for uranium in the vadose zone and PRZ using a combination of surface infiltration and injection into the PRZ in an approximately 1 hectare (3 acre) area of highest uranium contamination near the southern portion of waste sites 316-5 and 316-2; uranium sequestration at the top of the aquifer below the treatment zone to limit the mobility of any untreated uranium mobilized from the vadose zone during surface infiltration and injection into the PRZ.
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

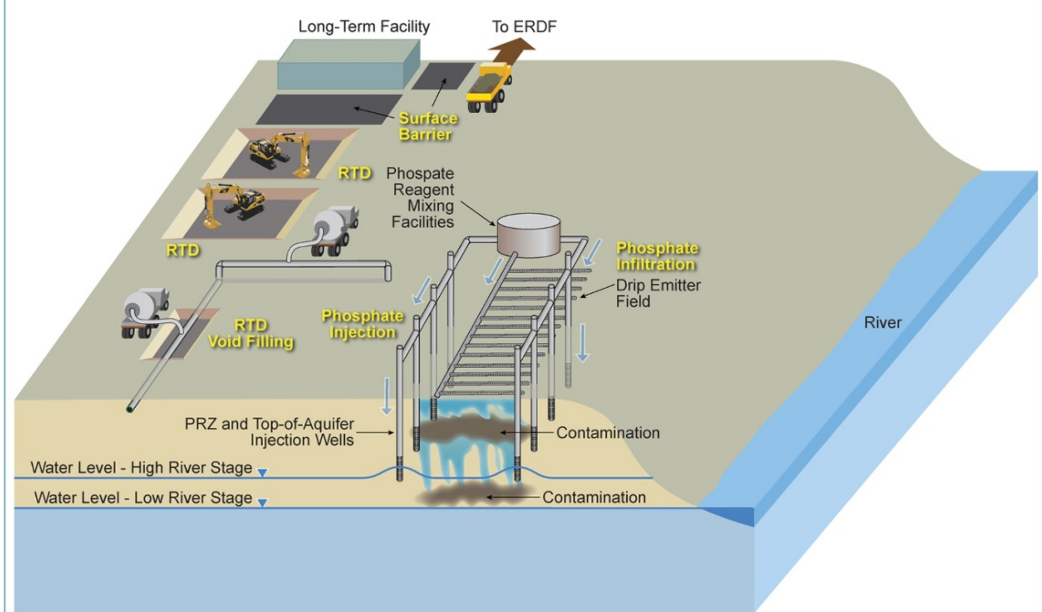
Groundwater

Alternative 3a uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring for uranium, gross alpha, and nitrate.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost	Waste Site Treatment	Groundwater Monitoring	TOTAL
Total Present Value of Alternative (Discounted)	$ 247,434,000	$ 11,480,000	$ 259,094,000

Note: Waste site treatment costs include the costs for institutional controls.

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Figure 17. Alternative 3a — RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

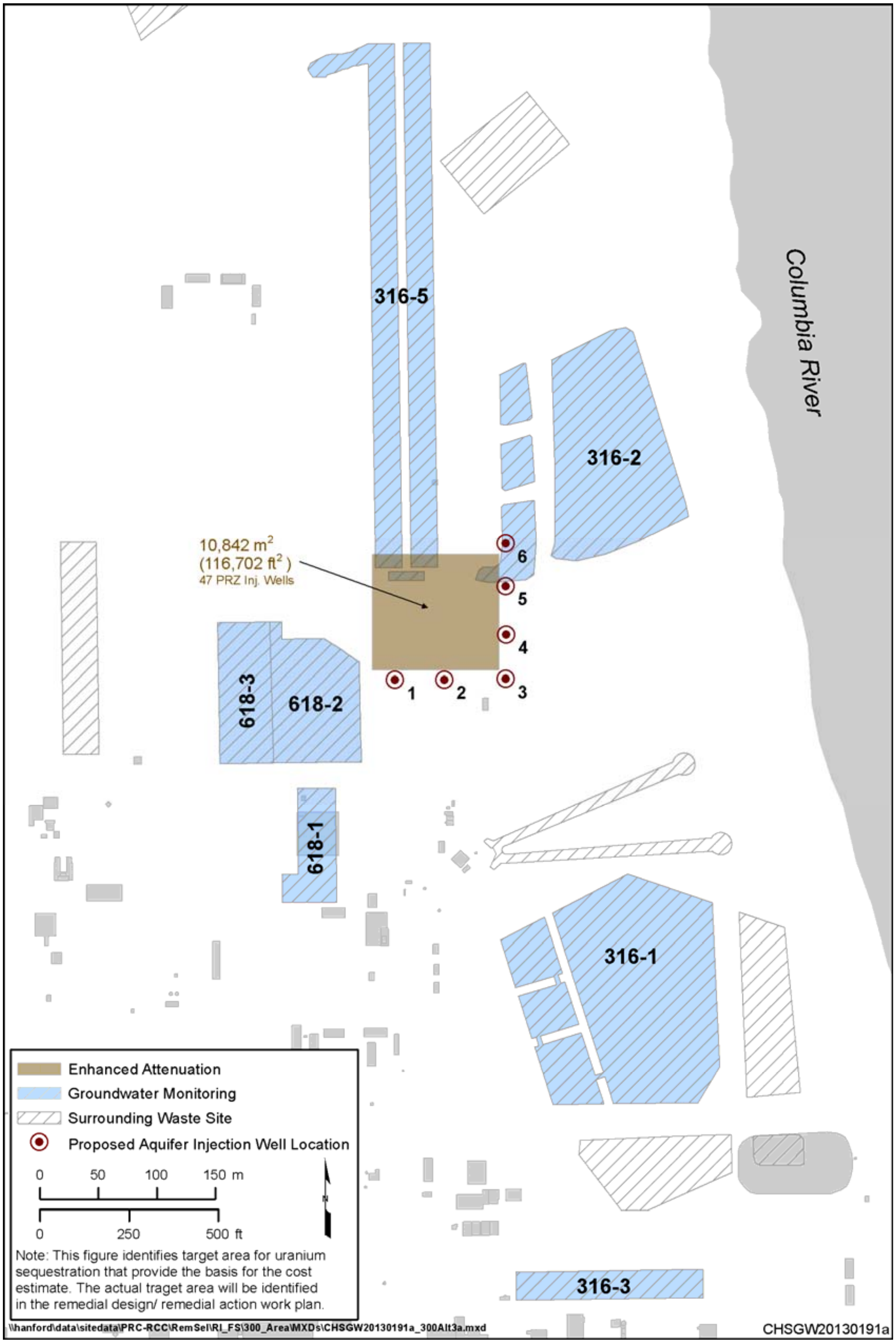


Figure 18. Target Area for Enhanced Attenuation (Alternative 3a)

Alternative 4 — RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

***Estimated capital cost:** $488 million*

***Estimated O&M cost:** $110 million*

***Estimated present value (discounted):** $537 million*

***Estimated time to achieve PRGs for uranium in groundwater:** 19 years*

***Estimated time to achieve PRGs for tritium in groundwater:** 18 years*

***Estimated time to achieve PRGs by RTD for waste sites:** 19 years*

Alternative 4 uses a combination of RTD at waste sites in the 300-FF-2 OU; focused deep RTD and uranium sequestration for deep uranium contamination in the vadose zone, PRZ, and top of the aquifer at the treatment zone; MNA for tritium, TCE, and cis-1,2-dichloroethene in groundwater; monitoring for uranium, gross alpha, and nitrate in groundwater; and ICs. This alternative reduces the time, as compared to the No Action alternative, required to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the continuing source of uranium in the PRZ.

With the exception of uranium sequestration and focused deep RTD, the remedial technologies for Alternative 4 are discussed in the "Common Elements" section of this Proposed Plan; all remedial technologies for Alternative 4 are shown on Figure 19. The specific design details will be provided in the work plan developed after the ROD resulting from this Proposed Plan. The focused deep RTD and the application of the uranium sequestration technology, which are unique to Alternative 4, include the following:

- Focused deep RTD will target the areas of highest contribution of residual uranium to groundwater from the deep vadose zone, as described in the conceptual model in the 300 Area RI/FS report (Section 4.8.3 of DOE/RL-2010-99). Standard excavation methods will be used because they are well established techniques and have been employed successfully at the Hanford Site for deep excavations
- Uranium sequestration in the vadose zone and PRZ using a combination of surface infiltration and deep injection techniques in areas of lower residual uranium concentration deeper than 4.6 m (15 ft) bgs that poses a risk to groundwater
- Uranium sequestration at the top of the aquifer at the treatment zone using injection wells at and downgradient of the waste sites shown in Figure 20. The primary purpose of injecting phosphate at the top of the aquifer at the treatment zone will be to sequester any untreated uranium that may be mobilized from the vadose zone during surface infiltration and injection into the PRZ.

Alternative 4 is estimated to take 7 years to complete the remedial action. This time period is based on one year to complete the RDR/RAWP, one year to complete the ongoing waste site RTD remediation prior to starting the deep RTD remediation, 2 years to complete the deep RTD of the 0.76 million m^3 (1.0 million yd^3) of uranium-contaminated soil, one year to backfill and grade the excavation to provide access to the areas for sequestration application and drilling, and 2 years to implement the uranium sequestration for the remaining deep uranium contamination. Following completion of these remedial actions, the model predicted 12 years to achieve the groundwater PRG for uranium. Therefore, the estimated time to achieve the groundwater DWS for uranium under Alternative 4 is 19 years.

The estimate of 12 years to achieve the DWS for uranium in the groundwater following completion of the remedial actions assumes a 100 percent reduction in the amount of uranium in the focused deep RTD areas and a 50 percent reduction in the amount of mobile uranium in the vadose zone as a result of sequestration. The estimated time to achieve the DWS does not include the impacts of additional uranium being driven from the vadose zone and PRZ to the aquifer by the application of dust suppression water during deep excavation.

Alternative 4: RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of Aquifer; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

The RTD component in Alternative 4 will replace the RTD component of the 300-FF-2 OU Interim Action ROD (EPA/ROD/R10-01/119). The RTD component in Alternative 4 incorporates the 300-FF-2 OU Interim Action ROD requirements to RTD the waste sites to protect human health from direct exposure as deep as 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites as deep as 4.6 m (15 ft) bgs to protect human health from direct exposure, and for the protection of groundwater and the Columbia River throughout the entire soil column. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Deep RTD in the areas of highest contribution of residual uranium to groundwater from the deep vadose zone (source removal).
- Uranium sequestration in the vadose zone and PRZ using a combination of surface infiltration and deep injection techniques in areas of lower residual uranium concentration deeper than 4.6 m (15 ft) bgs.
- Uranium sequestration at the top of the aquifer to remediate any untreated uranium mobilized from the vadose zone during surface infiltration and injection into the PRZ.
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

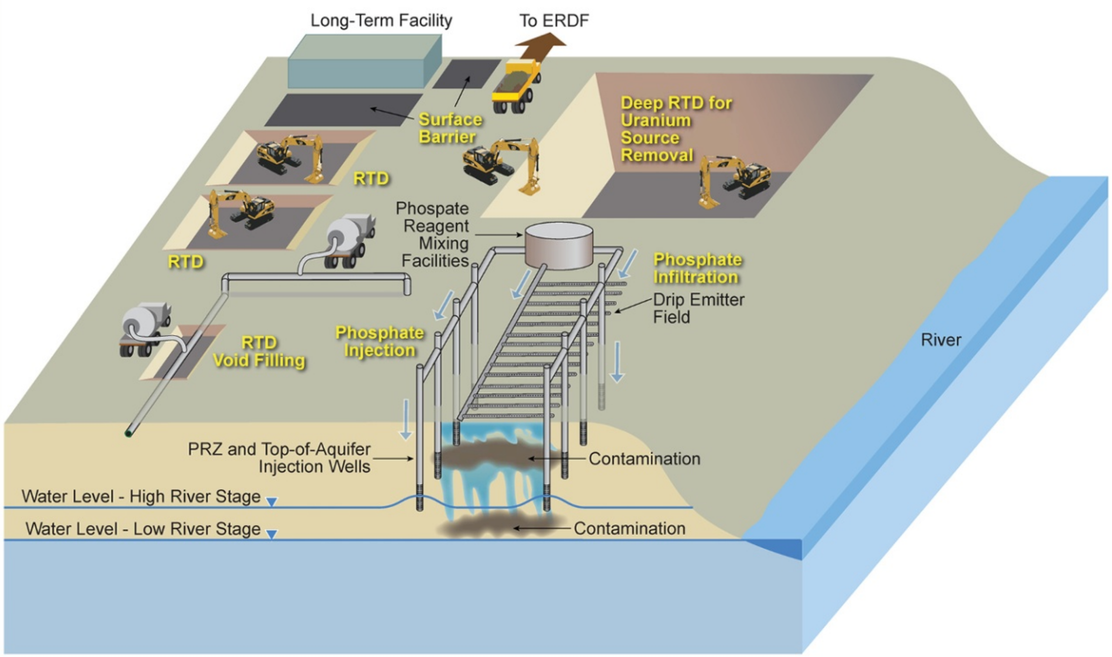
Groundwater

Alternative 4 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring for uranium, gross alpha, and nitrate.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost	Waste Site Treatment	Groundwater Monitoring	TOTAL
Total Present Value of Alternative (Discounted)	$525,591,000	$ 11,410,000	$ 537,001,000

Notes: 1) Waste site treatment costs include the costs for institutional controls.
2) The volume of contaminated soil associated with the Focused Deep RTD component of Alternative 4 (0.74 M yd3) will require approximately one half of an ERDF super cell. The cost of one super cell is estimated to be $27M. The costs presented above do not include the cost of constructing a partial super cell.

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Figure 19. Alternative 4 — RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

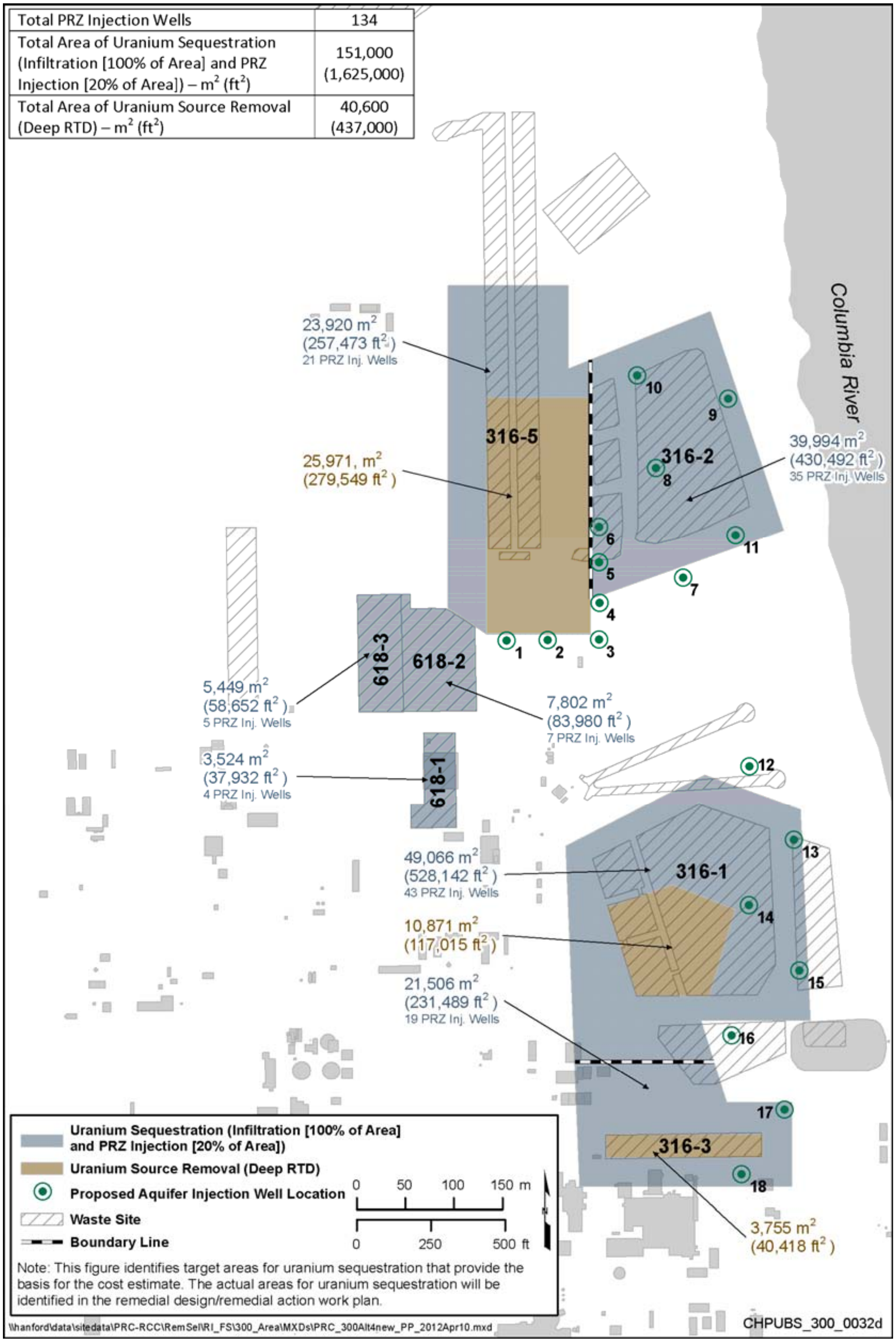


Figure 20. Areas for Uranium Sequestration and Focused Deep Uranium Source Removal (Alternative 4)

Alternative 5 — RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Estimated capital cost: *$1,309 million*

Estimated O&M cost: *$38 million*

Estimated present value (discounted): *$1,263 million*

Estimated time to achieve PRGs for uranium in groundwater: *17 years*

Estimated time to achieve PRGs for tritium in groundwater: *18 years*

Estimated time to achieve PRGs by RTD for waste sites: *19 years*

Alternative 5 uses a combination of RTD at waste sites in the 300-FF-2 OU; extensive deep RTD for uranium contamination in the vadose zone and PRZ contributing to the uranium groundwater plume; MNA for tritium, TCE, and cis-1,2-dichloroethene in groundwater; monitoring for uranium, gross alpha, and nitrate in groundwater; and ICs. This alternative reduces the time, as compared to the No Action alternative, to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS because it addresses the continuing source of uranium in the PRZ.

With the exception of extensive deep RTD, the remedial technologies for Alternative 5 are discussed in the "Common Elements" section of this Proposed Plan; all remedial technologies for Alternative 5 are shown on Figure 21. The extensive deep RTD technology, which is unique to Alternative 5, includes RTD to groundwater for the waste sites that contain the highest contribution of residual uranium to groundwater from the deep vadose zone and PRZ (Figure 22). Standard excavation methods will be used because they are well established techniques and have been employed successfully at the Hanford Site for deep excavations. It is estimated that extensive deep RTD will remove 3.3 million m^3 (4.3 million yd^3) of soil. Three new "super cells" would need to be constructed at the ERDF to dispose the excavated soil.

Alternative 5 is estimated to take 7 years to complete the remedial action. This time period is based on one year to complete the RDR/RAWP, one year to complete the ongoing waste site remediation prior to starting the deep RTD remediation, and 5 years to complete the deep RTD of the 3.3 million m^3 (4.3 million yd^3) of uranium-contaminated soil. Following completion of the remedial action, the model predicted 10 years to achieve the groundwater PRG for uranium. Note that the backfill and grading of the excavation are not included in the time frame to achieve the uranium PRG in groundwater because the model prediction is based on removal of the contamination. Therefore, the estimated time to achieve the groundwater DWS for uranium under Alternative 5 is 17 years.

The estimated time period of 10 years to achieve the DWS for uranium following completion of the remedial action assumes a 100 percent reduction in the amount of uranium in the extensive deep RTD areas.
The estimated time to achieve the DWS does not include the impacts of additional uranium being driven from the vadose zone and PRZ to the aquifer by the application of dust suppression water during deep excavation.

Introduction ➜ Site Background ➜ Site Characteristics ➜ Scope and Role ➜ Summary of Site Risks ➜ Remedial Action Objectives ➜ Summary of Remedial Alternatives ➜ Evaluation of Remedial Alternatives ➜ Preferred Remedial Alternative ➜ Community Participation

Evaluation of Remedial Alternatives

As part of the FS, DOE and EPA evaluated each remedial alternative using the CERCLA threshold and balancing criteria described in the NCP (40 CFR 300.430[e][9]) to assist in identifying a preferred alternative. Following this evaluation, a comparative analysis was performed to assess the overall performance of each alternative relative to the others. Figure 23 presents the nine CERCLA evaluation criteria, which are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria.

Alternative 5: RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Overview

Waste Sites

The RTD component in Alternative 5 will replace the RTD component of the 300-FF-2 OU Interim Action ROD (EPA/ROD/R10-01/119). The RTD component in Alternative 5 incorporates the 300-FF-2 OU Interim Action ROD requirements to RTD the waste sites to protect human health from direct exposure as deep as 4.6 m (15 ft) bgs. For waste sites that have not undergone interim actions, the actions will vary depending on the nature and extent of contamination at the waste site, and may include one or more of the following:

- RTD of the waste sites as deep as 4.6 m (15 ft) bgs to protect human health from direct exposure, and for the protection of groundwater and the Columbia River throughout the entire soil column. Contaminated non-pipeline engineered structures (e.g., burial ground trenches, drums, caissons, and VPUs) present at greater depths will also be removed.
- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines at waste site 300-15 to variable depths to achieve HHE direct exposure and groundwater protection cleanup levels.
- Extensive deep RTD of the waste sites with the highest contribution of residual uranium to groundwater from the deep vadose zone and PRZ (source removal).
- Temporary surface barriers for waste sites adjacent to long-term facilities for groundwater protection, as needed.
- Interim void filling of pipelines adjacent to long-term facilities for groundwater protection, as needed.
- Institutional Controls.

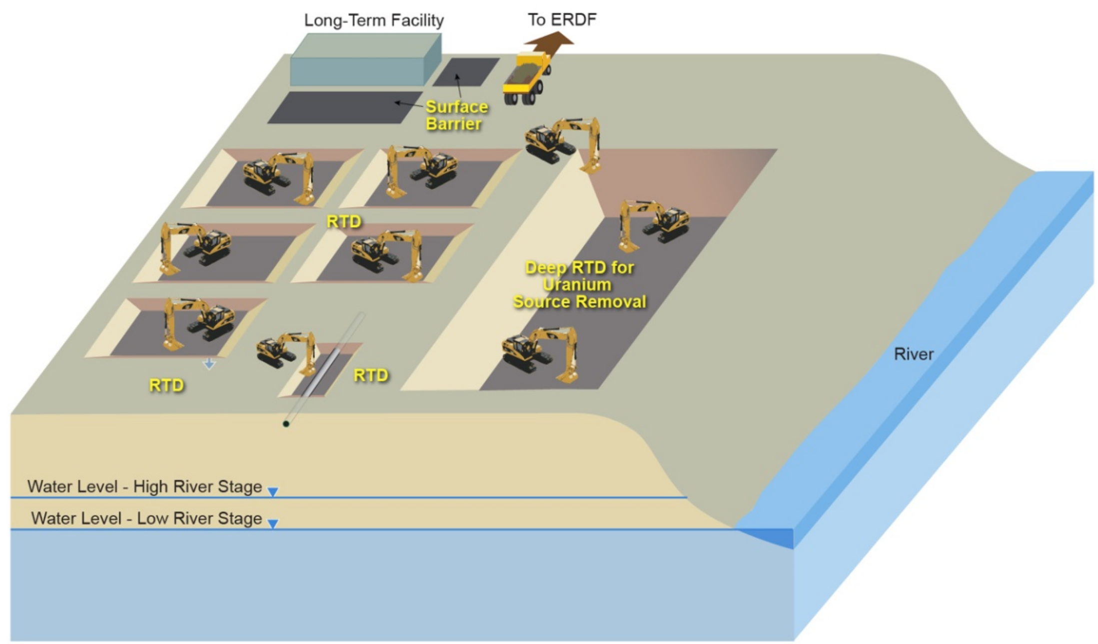
Groundwater

Alternative 5 uses MNA, monitoring, and institutional controls for groundwater. The scope of the actions includes:

- MNA for tritium, TCE, and cis-1,2-DCE in groundwater.
- Groundwater monitoring for uranium, gross alpha, and nitrate.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Monitoring	TOTAL
Total Present Value of Alternative (Discounted)	$ 1,260,477,000	$ 2,450,000	$ 1,262,927,000

Notes: 1) Waste site treatment costs include the costs for institutional controls.
2) The volume of contaminated soil associated with the Extensive Deep RTD component of Alternative 5 (3.5 M yd3) will require the construction of approximately three ERDF super cells, each one costing approximately $27M. The costs presented above do not include the cost of constructing the super cells.

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Figure 21. Alternative 5 — RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

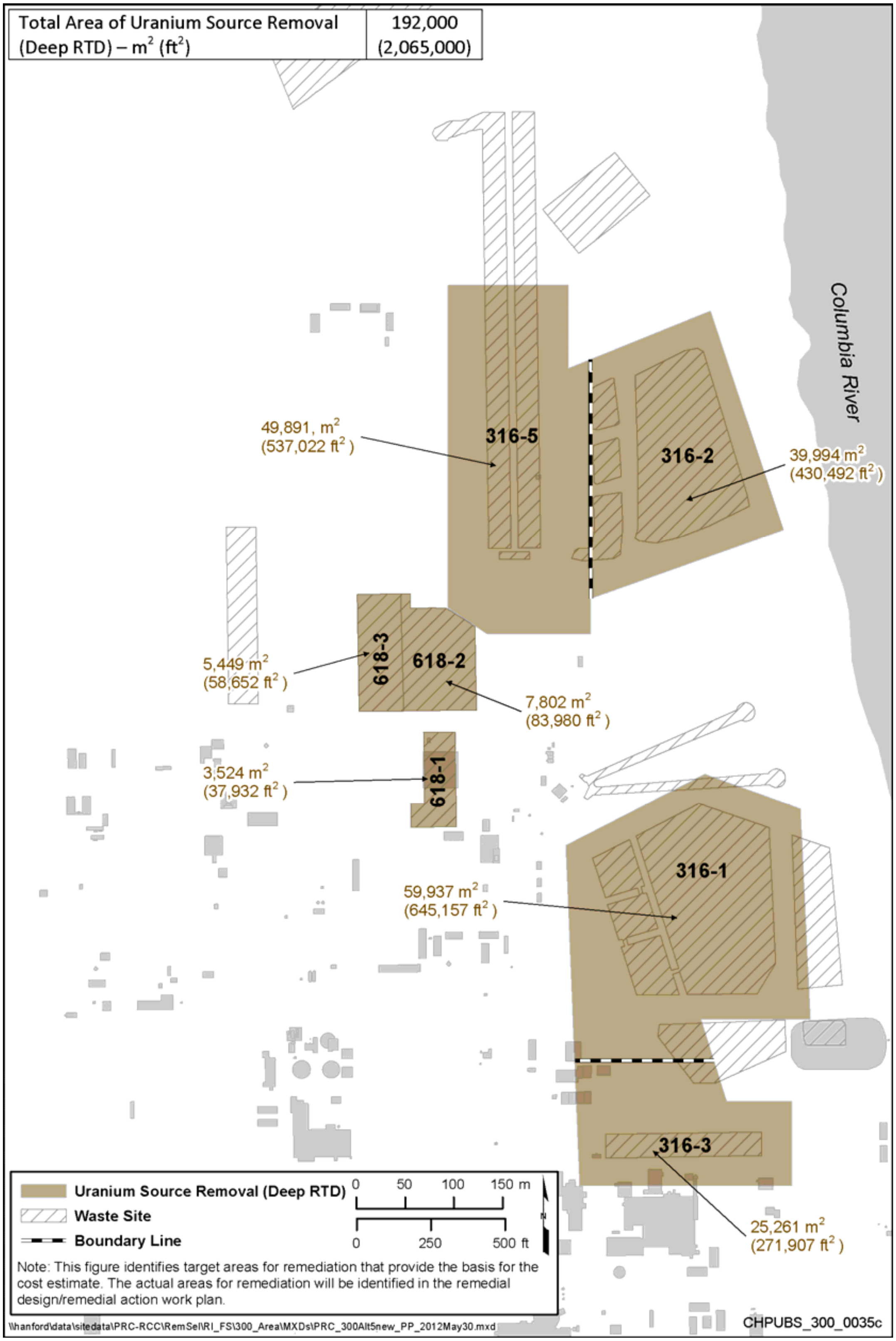

Figure 22. Areas for Extensive Deep RTD (Alternative 5)

A remedial alternative must satisfy the two CERCLA threshold criteria of overall protection of HHE and compliance with ARARs to be considered a viable alternative. The five CERCLA balancing criteria allow for a comparison of major trade-offs among the alternatives. The two CERCLA modifying criteria (state acceptance and community acceptance) cannot be fully considered until after comments are received on this Proposed Plan. After completion of the comment period, DOE and EPA will consider the comments received before issuing a ROD.

The 300-FF-2 and 300-FF-5 OUs are proposed for a ROD under Alternatives 2, 3, 3a, 4, and 5. There are currently interim action RODs for each of these two OUs. The 300-FF-1 OU ROD is proposed to be amended if Alternative 3, 3a, 4, or 5 is selected. The ROD for the 300-FF-2 OU and the 300-FF-5 OU and the ROD amendment for the 300-FF-1 OU (if necessary), would be in a single decision document.

The following discussion describes the comparative evaluation of alternatives that was used to identify the preferred alternative. The comparative evaluation focuses on remediation of the residual uranium in the deep vadose zone and PRZ because (1) remediation of the uranium in this zone is the key to reducing the uranium concentration in the groundwater to below the DWS, and (2) it is the only remediation component that differs for each alternative. A more detailed explanation of the comparative analysis is provided in Section 7.2 of the 300 Area RI/FS report addendum (DOE/RL-2010-99-ADD1). The comparative evaluation is summarized in Table 3.

Threshold Criteria

Overall Protection of Human Health and the Environment

Alternative 1 (No Action) proposes no remediation of waste sites (i.e., interim actions would end) or groundwater, and ICs would not be maintained. Alternatives 2, 3, 3a, 4, and 5 include the same common elements for remediation of all soil contaminants other than residual uranium in the deep vadose zone and PRZ; RTD at waste sites; groundwater MNA for tritium, TCE, and cis-1,2-dichloroethene; groundwater monitoring for uranium, gross alpha, and nitrate; and ICs.

The six remedial alternatives provide different approaches for remediating the residual uranium contamination in the deep vadose zone and PRZ:

- **Alternative 1:** Proposes no remediation.
- **Alternative 2:** Proposes groundwater monitoring for the deep uranium contamination.
- **Alternative 3:** Proposes a phased approach for in situ immobilization of deep uranium contamination through phosphate injection.
- **Alternative 3a:** Proposes enhanced attenuation of deep uranium contamination through phosphate injection in the approximately 1 ha (3 ac) area contributing to the persistent groundwater contamination near waste sites 316-5 and 316-2.
- **Alternative 4:** Proposes removing the greatest mass of deep uranium contamination by excavating to groundwater, followed by in situ immobilization for the lesser mass of deep uranium contamination through phosphate injection.
- **Alternative 5:** Proposes removing the deep uranium contamination by excavating to groundwater where the uranium exceeds groundwater protection PRGs.

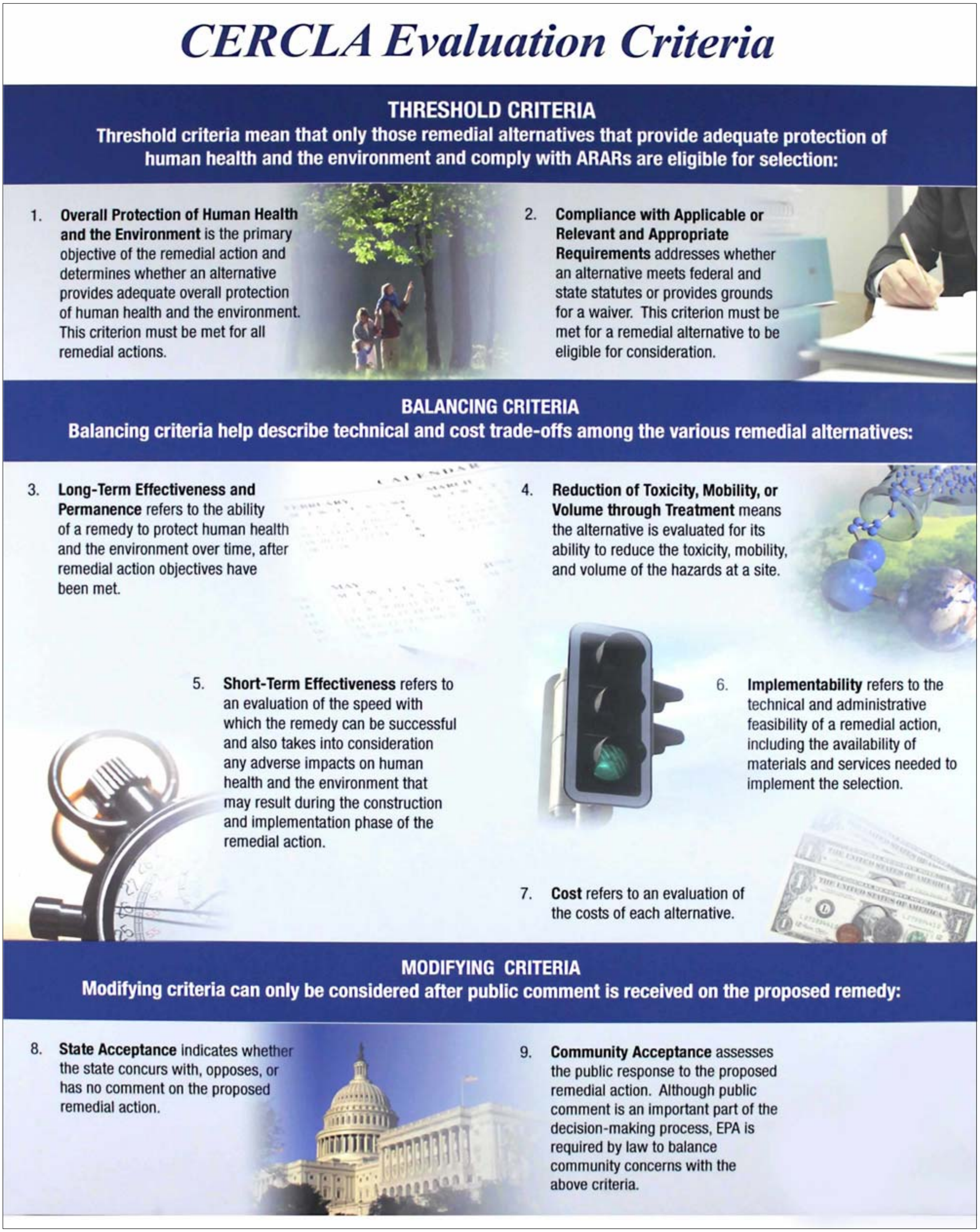

Figure 23. CERCLA Evaluation Criteria

Table 3. Summary of Comparative Analysis of Alternatives

CERCLA Criteria	Remedial Alternatives					
	1	2	3	3a	4	5
Threshold Criteria						
Protection of human health/environment	No	Yes	Yes	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes	Yes	Yes
Balancing Criteria						
Long-term effectiveness and permanence	Not evaluated	★★☆	★★☆	★★☆	★★☆	★★★
Reduction of toxicity, mobility, or volume through treatment	Not evaluated	★☆☆	★★★	★★★	★★☆	★☆☆
Short-term effectiveness and time to achieve RAOs[h]	Not evaluated	★☆☆	★★★	★★★	★★☆	★☆☆
Implementability	Not evaluated	★★★	★★☆	★★★	★★☆	★★☆
Estimated time to achieve RAOs for uranium in groundwater (years)[a]	—	28	22	22 to 28 [b]	19	17
Estimated time to achieve RAOs for tritium in groundwater (years)[c]	—	18	18	18	18	18
Estimated time to achieve RAOs by RTD for waste sites (years)[d]	—	19	19	19	19	19
Cost (millions)[e]						
Waste sites[f,g]	$0	$230	$355	$247	$526	$1,260
Groundwater	$0	$3.3	$11.5	$11.5	$11.4	$2.5
Total cost (millions)[e]	$0	$233	$367	$259	$537	$1,263
Modifying Criteria						
State acceptance	To be determined					
Community acceptance	To be determined					

Note: Although the remedial alternatives developed for evaluation do not have specific provisions for sustainable elements, those values can be incorporated during the remedial design phase.

The comparative evaluation metrics are defined as follows:

★☆☆ = Expected to perform less well with more disadvantages or uncertainty when compared to the other alternatives.

★★☆ = Expected to perform moderately well some disadvantages or uncertainties when compared to the other alternatives.

★★★ = Expected to perform best with fewer disadvantages or uncertainties when compared to the other alternatives.

Table 3. Summary of Comparative Analysis of Alternatives

CERCLA Criteria	Remedial Alternatives					
	1	2	3	3a	4	5

a. The estimated time to achieve PRGs for uranium in groundwater is based on the 90th percentile, or the 95 percent upper confidence limit on the mean, of the annual dissolved concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

b. The estimated time to achieve PRGs for uranium in groundwater for Alternative 3a is expected to range between 22 years (time frame for Alternative 3) and 28 years (time frame for Alternative 2). Since enhanced attenuation targets the area contributing to highest groundwater contamination, the estimated time to achieve the PRG is expected to be similar to Alternative 3.

c. The tritium concentration is estimated to be below the DWS by 2031 (PNNL-15293, *Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground*). The estimate of 18 years to achieve the PRG is based on a starting date of 2013.

d. The estimated time to achieve PRGs for waste sites is based on PNNL's use of 300 Area long-term facilities until 2027, completion of RTD at waste sites adjacent to the long-term facilities within 5 years after PNNL's use (2032), and a starting date of 2013.

e. These cost estimates represent the total present value (discounted), prepared to meet the -30 to +50 percent range of accuracy recommended in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*.

f. Does not include the cost for construction of additional ERDF super cells at $27.1 million each. The costs for additional ERDF super cells would be included as part of the ERDF ROD revision (EPA/ROD/R10-95/100, *EPA Superfund Record of Decision: Hanford 200-Area, Benton County, Washington*).

g. Does not include costs for waste sites that have begun remediation under the interim action ROD by January 2013.

h. The evaluation of short-term effectiveness emphasizes consideration of any adverse impacts on human health and the environment associated with implementation of the remedial action. Time to achieve RAOs is provided for each of the remedy elements.

Alternatives:

Alternative 1: No Action

Alternative 2: RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Alternative 3: RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 3a: RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Alternative 4: RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 5: RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

ARAR = applicable or relevant and appropriate requirement
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DWS = drinking water standard
ERDF = Environmental Restoration Disposal Facility
IC = institutional control
MNA = monitored natural attenuation
PNNL = Pacific Northwest National Laboratory
PRG = preliminary remediaion goal
PRZ = periodically rewetted zone
RAO = remedial action objective
ROD = Record of Decision
RTD = removal, treatment, and disposal

Alternative 1 does not achieve RAOs and does not meet the threshold criterion for protection of HHE; therefore, it is not evaluated further. Alternatives 2, 3, 3a, 4, and 5 would achieve the RAOs and meet the threshold criterion for protection of HHE; therefore, these alternatives are evaluated further. The estimated times to achieve RAOs for uranium in groundwater, after the remedial actions for uranium in the deep vadose zone and PRZ have been completed, are provided for each alternative in the discussion of short-term effectiveness in this Proposed Plan.

Compliance with Applicable or Relevant and Appropriate Requirements

The ARAR identification process is based on CERCLA, the NCP (40 CFR 300), and guidance. The lead and non-lead agencies are to identify requirements applicable or relevant and appropriate to the release or remedial action at a CERCLA site (40 CFR 300.400[g], "General"). Alternative 1 (No Action) does not satisfy the threshold criterion for ARAR compliance (or the justification of a waiver). Alternatives 2, 3, 3a, 4, and 5 will comply with ARARs.

Section 8.1.2 of the 300 Area RI/FS report (DOE/RL-2010-99) contains a detailed discussion on how the ARARs evaluation process is conducted through the remedial action process in accordance with the NCP (40 CFR 300.430[f][1][ii][B][2]). Table 8-2 in the 300 Area RI/FS report lists all of the potential federal and Washington State ARARs for these remedial actions. The ARARs will be finalized as part of the ROD.

Potential Chemical-Specific ARARs. Some of the key potential chemical-specific ARARs for this remedial action are the substantive (non-administrative) elements of the federal and state regulations that implement the DWSs under the *Safe Drinking Water Act of 1974* (40 CFR 141, "National Primary Drinking Water Regulations") and MTCA (WAC 173-340-720[4], "Groundwater Cleanup Standards") and health protection (WAC 173-340-720[7]).

Since the federal DWSs and specific groundwater cleanup sections of MTCA (WAC 173-340) are potential ARARs, the remedial alternatives were developed to achieve ARARs for each identified COC so groundwater present in the 300-FF-5 OU could be used as a future drinking water source.

Potential Location-Specific ARARs. Potential location-specific ARARs identified for these OUs include those that protect cultural, historic, and Native American sites and artifacts under the *Native American Graves Protection and Repatriation Act of 1990*, *Archaeological and Historic Preservation Act of 1974*, and the *National Historic Preservation Act of 1966*. The *Migratory Bird Treaty Act of 1918* is a potential location-specific ARAR.

The *National Historic Preservation Act of 1966* is a potential ARAR for remedial actions where cultural resources are present. Remediation may have the potential to impact cultural resources. An analysis of cultural resource impacts will be taken before any remedial action occurs in the 300 Area. This will include an assessment of the cultural resources known to be present and a qualitative comparison to the risk posed by the contaminants present at a site in accordance with the *Hanford Cultural Resources Management Plan* (DOE/RL-98-10). Preservation of cultural and historic properties under the *National Historic Preservation Act of 1966* is considered in remedial action decisions under the Tri-Party Agreement (Ecology et al., 1989).

Potential Action-Specific ARARs. Potential action-specific ARARs relate to waste management activities, solid and dangerous waste regulations within WAC 173-303 ("Dangerous Waste Regulations") and WAC 173-350 ("Solid Waste Handling Standards"), and radioactive waste management under the *Atomic Energy Act of 1954*. The other major category of potential action-specific ARARs concerns standards for controlling air emissions to the environment in accordance with WAC 246-247 ("Radiation Protection Air Emissions") and WAC 173-480 ("Ambient Air Quality Standards and Emission Limits for Radionuclides").

Alternatives 2, 3, 3a, 4, and 5 would comply with ARARs throughout the remedial action and at the time of completion, and would therefore meet this threshold criterion. There are no waivers from ARARs being sought for these alternatives. Remedial actions proposed under these alternatives would be designed to meet chemical-specific, location-specific, and action-specific ARARs. For groundwater, Alternatives 2, 3, 3a, 4, and 5 are anticipated to achieve DWSs within the time frames shown in Table 3. The time to achieve the DWS is highly influenced by the annual high river stage.

Balancing Criteria

Long-Term Effectiveness and Permanence

The criterion of long-term effectiveness and permanence is used to compare the ability of the remedial alternatives to maintain protection of HHE after the RAOs have been met. Factors that are considered include whether (1) the remedy will degrade over time, (2) the remedy relies on natural processes that do not require human intervention, and (3) the remedy has a high degree of certainty in performance to meet and maintain RAOs.

After the RAOs have been met, the remedies in Alternatives 2, 3, 3a, 4, and 5 all rely only on natural processes to maintain the RAOs and are not expected to degrade. All of the alternatives rely on annual high river stage flushing the residual uranium from the PRZ. However, the alternatives have different degrees of uncertainty with meeting the RAOs because of the amount of mobile uranium remaining in the PRZ throughout the remedial action.

Alternatives 4 and 5 are expected to achieve long-term effectiveness and permanence in the 300 Area for the greatest mass of deep uranium contamination that is removed through excavation. However, these alternatives do not remove the uranium contamination that has migrated laterally in the PRZ or aquifer. Alternatives 3 and 3a are expected to achieve long-term effectiveness and permanence for the greatest mass of deep uranium contamination using uranium sequestration through direct formation of autunite, a stable uranium mineral that has low solubility, in the treated area. Alternatives 3 and 3a have the potential to remediate more deep uranium contamination than Alternatives 4 and 5 because the phosphate solutions can migrate laterally within the deep vadose zone, PRZ, and aquifer. However, some uncertainty is associated with Alternatives 3 and 3a because uranium sequestration has not been implemented full-scale at the Hanford Site. Alternative 2 is expected to achieve long-term effectiveness and permanence but relies on natural processes to remove the residual uranium contamination in the deep vadose zone. As a result, Alternative 2 has uncertainty associated with the long-term migration of uranium concentrations in the deep vadose zone to the groundwater due to the variable river stage.

Alternatives 2, 3, 3a, 4, and 5 will achieve long-term effectiveness and permanence, with Alternative 5 expected to perform best for this criterion.

Reduction of Toxicity, Mobility, or Volume through Treatment

The criterion of reduction of TMV through treatment is used to compare the anticipated performance of specific treatment technology components of the remedial alternatives. Alternatives 2, 3, 3a, 4, and 5 reduce the TMV of principal threat waste through treatment. Alternatives 2, 3, 3a, 4, and 5 do not reduce the TMV through treatment of most of the non-principal threat waste resulting from RTD. Non-principal threat waste resulting from RTD will be treated to reduce toxicity and mobility when necessary to (1) protect workers and prevent unacceptable environmental releases during the remedial action and after disposal, and/or (2) meet the waste acceptance criteria of the disposal facility.

For the greatest mass of uranium contamination in the deep vadose zone and PRZ, Alternatives 3 and 3a provide the highest reduction of TMV through treatment because mobility is reduced by uranium sequestration in the treated area. Even though Alternative 3a treats a smaller area than Alternative 3, they both target the greatest mass of uranium contamination in the deep vadose zone and are expected to have similar groundwater results. Alternative 4 also uses sequestration to reduce the TMV of deep uranium though treatment, but it treats less uranium than Alternatives 3 and 3a because it is not applied to the area of the greatest mass of uranium contamination.

Alternatives 2, 3, 3a, 4, and 5 provide reduction of TMV through treatment to different levels, with Alternatives 3 and 3a performing the best and Alternative 4 the second best for this criterion.

Short-Term Effectiveness

The criterion of short-term effectiveness is used to compare the ability of the remedial alternatives to maintain protection of HHE during construction and implementation of the remedy until the RAOs have been met. Factors that are considered include (1) the speed with which the remedy can be successful, and (2) any adverse impacts on HHE during the construction and implementation phase of the remedial action.

For Alternatives 2, 3, 3a, 4, and 5, the estimated time to achieve RAOs for the waste sites is the same because several of the waste sites are collocated with long-term facilities. Remediation of these waste sites is assumed to occur within 19 years (by 2032), which is 5 years after the long-term facilities are no longer in use.

From the standpoint of uranium cleanup in the aquifer, Alternative 2 is the most likely to extend the remediation time frame beyond that required for the waste sites because the estimated time to achieve the RAOs for uranium in the groundwater is longer than the time required for the remediation of waste sites. In addition, the estimated time for Alternative 2 to achieve the RAOs for uranium in groundwater has the most uncertainty because it has the most dependence on future magnitudes of river fluctuation within the PRZ.

For Alternatives 3, 3a, 4, and 5, the estimated times to achieve RAOs for uranium in groundwater are identified in Table 3 and include the time estimated for implementation. The following schedule assumptions are made based on an anticipated ROD in 2013:

- Alternative 2 does not include remediation of the residual uranium in the deep vadose zone and PRZ contributing to groundwater. The estimated time to achieve groundwater RAOs for uranium begins in 2013 and takes 28 years (by 2041). The uncertainty in the estimated time to achieve the uranium DWS in the groundwater is the highest for Alternative 2, which depends primarily on the magnitude of future river-stage fluctuations and does not benefit from any remedial actions in the deep vadose zone and PRZ.

- Alternative 3 is estimated to take 6 years to complete the remedial action. Following completion of the remedial action, the model predicted 16 years to achieve the groundwater RAO for uranium. Therefore, the estimated time to achieve groundwater RAOs for uranium under Alternative 3 is 22 years (by 2035). Alternative 3 has less uncertainty than Alternative 2 but also relies on the magnitude of future river-stage fluctuations for the annual rate of uranium attenuation.

- Alternative 3a is estimated to take 4 years to complete the remedial action. This alternative addresses the deep uranium contamination contributing to the persistent groundwater contamination hot spot and, therefore, the estimated time to achieve the groundwater RAO for uranium is expected to range between Alternative 3 (22 years, by 2035) and Alternative 2 (28 years, by 2041). Alternative 3a has more uncertainty than Alternative 3 but less than Alternative 2, and it also relies on the magnitude of future river-stage fluctuations for the annual rate of uranium attenuation.

- Alternative 4 is estimated to take 7 years to complete the remedial action. Following completion of the remedial action, the model predicted 12 years to achieve the groundwater RAO for uranium. Therefore, the estimated time to achieve the groundwater RAO for uranium under Alternative 4 is 19 years (by 2032). Alternative 4 has similar uncertainty to Alternative 3, because Alternative 4 still relies on the magnitude of future river-stage fluctuations for the annual rate of uranium attenuation in the PRZ that is outside the area of the RTD actions.

- Alternative 5 is estimated to take 7 years to complete the remedial action. Following completion of the remedial action, the model predicted 10 years to achieve the groundwater RAO for uranium. Therefore, the estimated time to achieve the groundwater RAO for uranium under Alternative 5 is 17 years (by 2030). Alternative 5 has similar uncertainty to Alternative 4, because Alternative 5 still relies on the magnitude of future river-stage fluctuations for the annual rate of uranium attenuation in the PRZ that is outside the area of the RTD actions.

For Alternatives 4 and 5, which both include deep RTD of residual uranium contamination, the estimated time to achieve RAOs is 19 and 17 years, respectively. Given that the removal of contaminated soil requires significant funding and building infrastructure (e.g., building new ERDF super cells and haul roads), it is anticipated that RTD of these waste sites may take longer than the estimated times identified above. As a result, the estimated times to achieve RAOs for Alternatives 4 and 5 are likely to be longer than the times identified in Table 3, which are based only on excavation rates.

Although the deep excavation components of Alternatives 4 and 5 might appear to have higher short-term effectiveness, deep RTD includes a number of unintended consequences. The deep RTD to groundwater for the uranium-contaminated waste sites includes the minimum, standard safe-practice layback of 1.5 m (5 ft) for each vertical 1 m (3.3 ft) of excavation depth. This deep RTD will create a very large disturbed area and will generate approximately 0.76 million m^3 (1.0 million yd^3) of soil in Alternative 4 and 3.3 million m^3 (4.3 million yd^3) of soil in Alternative 5 for handling and disposal. Given that large volumes of contaminated soil that will be generated, three new super cells will need to be constructed at the ERDF to dispose the excavated deep contaminated soil for Alternative 5. The subsequent backfill of the excavated areas will require loading, transporting, and handling a comparable volume of clean soil from a different location. For Alternative 4, the excavation and backfill of a combined 1.5 million m^3 (2.0 million yd^3) of soil are estimated to require approximately 6.3 million km (3.9 million mi) of truck haulage. The trucks would burn 10 million L (2.6 million gal) of diesel fuel and generate 31,000 metric tons (34,000 tons) of carbon dioxide and 250 metric tons (276 tons) of mono-nitrogen oxides. For Alternative 5, the excavation and backfill of a combined 6.6 million m^3 (8.6 million yd^3) of soil are estimated to require approximately 27 million km (17 million mi) of truck haulage. The trucks would burn 43 million L (11 million gal) of diesel fuel and generate 133,000 metric tons (147,000 tons) of carbon dioxide and 1,100 metric tons (1,200 tons) of mono-nitrogen oxides. Consumption of these resources and associated air pollution are considered in the short-term effectiveness criterion.

Excavation technologies require dust control for worker safety and airborne contamination control for onsite and offsite receptors. Application of dust-control water during excavation of the vadose zone soils and partially saturated soils in the PRZ will release residual uranium contamination to the groundwater, as evidenced by the uranium plume that was produced by the excavation of vadose zone soil at the 618-7 and 618-10 Burial Grounds. As a result, the deep RTD in Alternatives 4 and 5 is likely to release more uranium to the groundwater and the Columbia River than the other alternatives in the short term. The additional mobile uranium released to the groundwater will lengthen the time estimated to reach RAOs, but this could not be quantified with sufficient certainty for inclusion in this evaluation. The impact from this mobilized uranium was not included in the time to achieve RAOs presented in Table 3.

Potential effects to site workers from implementing any actions onsite would be controlled and mitigated through health and safety procedures, the use of adequate worker personal protective equipment, and a perimeter dust/air monitoring program that would provide timely and adequate data to mitigate any potential offsite effects in a timely manner. Because Alternatives 4 and 5 include RTD to depths greater than 4.6 m (15 ft), increased safety challenges would result to workers compared to implementing a less invasive approach such as uranium sequestration.

Alternatives 3 and 3a do not cause the extent of adverse effects associated with deep excavation. Uranium sequestration proposed in Alternatives 3 and 3a would be effective in reducing the flux of the greatest mass of uranium to groundwater once the phosphate reagent contacts the uranium contaminant for a sufficient time to produce a stable uranium mineral. The deep RTD proposed in Alternatives 4 and 5 to remove the greatest mass of uranium cannot be implemented without generating the unintended consequences of adverse effects on HHE because of the large excavation footprint, large consumption of fuel resources and resulting air pollution, and high potential for mobilizing much greater mass of uranium to the groundwater and to the river. Alternatives 3 and 3a were ranked as having the highest short-term effectiveness because (1) they do not extend the remediation time frame beyond the time required for the waste sites, and (2) they minimize adverse effects on HHE.

Implementability

The criterion of implementability is used to compare the technical and administrative feasibility of the remedial alternatives. Factors considered include the availability of materials and services needed to implement the remedy components. Alternatives 2, 3, 3a, 4, and 5 include remedies that are technically and administratively feasible and are, therefore, considered implementable.

Alternative 5 is considered less implementable than Alternatives 3, 3a, and 4 because of the need to construct new ERDF super cells, identify a suitable borrow pit for obtaining backfill material, and build and maintain haul roads. Removal of residual uranium detected in the deep vadose zone or PRZ in the sidewalls of the planned excavation footprint will require additional excavation from the ground surface. Excavation of the PRZ is limited to periods when the river stage is low and the PRZ is available for excavation. The focused deep RTD in Alternative 4 has similar disadvantages for implementation.

Alternatives 3, 3a, and 4 have uncertainties associated with delivering the phosphate solutions to the uranium contamination in the deep vadose zone and PRZ. To address these uncertainties, Alternatives 3, 3a, and 4 apply phosphate at the surface, in the vadose zone, and in the aquifer. Alternative 3 also uses a phased approach that provides an opportunity to optimize the delivery processes.

Alternatives 3, 3a, and 4 use wells to deliver the phosphate solutions to the PRZ and top of the aquifer at the treatment zone. Alternative 3, which requires 311 wells, and Alternative 4, which requires 134 wells, are considered less implementable than Alternative 3a, which requires 47 wells.

Cost

Estimated design, construction, ***operations and maintenance (O&M)***, and decommissioning costs were developed for each alternative. Costs are not included for waste sites that have begun remediation under the interim action ROD by January 2013. Costs for O&M were based on the alternative-specific remedial time frames, which range from 19 to 28 years. The total costs are $233 million for Alternative 2; $259 million for Alternative 3a; $367 million for Alternative 3; $537 million for Alternative 4; and $1.263 billion for Alternative 5. The costs for remediation of waste sites and groundwater are presented for each alternative in Table 4. The costs are the lowest for Alternative 2 and the highest for Alternative 5.

Total ***present value (discounted)*** costs were estimated using the real discount rate published in Appendix C of Office of Management and Budget Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Program – Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis* (OMB, 1999). Based on this guidance and the durations of the remedial alternative components, the real discount rates ranged from 0.7 percent to 2.0 percent (Appendix K of the 300 Area RI/FS report [DOE/RL-2010-99]).

Table 4. Summary of Costs for Remedial Alternatives

Remedial Alternative	Capital Cost	Annual Operations and Maintenance Cost	Total Present Value
1	$0	$0	$0
2	$245,412,000	$40,096,000	$233,011,000
3	$279,567,000	$144,113,000	$366,839,000
3a	$254,277,000	$43,708,000	$259,094,000
4	$487,584,000	$109,988,000	$537,001,000
5	$1,309,452,000	$38,315,000	$1,262,927,000

Alternatives:

Alternative 1: No Action

Alternative 2: RTD at Waste Sites; MNA; Groundwater Monitoring; and ICs

Alternative 3: RTD at Waste Sites; Phased Approach for Implementation of Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 3a: RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

Alternative 4: RTD at Waste Sites; Focused Deep RTD in the Vadose Zone and PRZ; Uranium Sequestration in the Vadose Zone, PRZ, and Top of the Aquifer; MNA; Groundwater Monitoring; and ICs

Alternative 5: RTD at Waste Sites; Extensive Deep RTD in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs

IC = institutional control

MNA = monitored natural attenuation

PRZ = periodically rewetted zone

RTD = removal, treatment, and disposal

Alternatives 2, 3, 3a, 4, and 5 do not include costs associated with providing additional onsite waste disposal capacity. A cost of $27.1 million is associated with construction of a new ERDF super cell for disposal of the excavated materials from the waste sites, which has not been added to the overall cost estimates. Alternative 5, which involves excavation of the largest volume of contaminated soil, would require three super cells to dispose the soil at ERDF. Construction costs for the additional super cells would be included as a modification to the existing ERDF ROD (EPA/ROD/R10-95/100).

Modifying Criteria

State and community input received to date has been considered in the development of this Proposed Plan. Modifying criteria will be considered after receiving comments on this Proposed Plan. In the final balancing of tradeoffs between alternatives upon which the final remedy selection is based, modifying criteria and balancing criteria are both important.

Preferred Remedial Alternative

Alternative 3a (RTD at Waste Sites; Enhanced Attenuation for Uranium in the Vadose Zone and PRZ; MNA; Groundwater Monitoring; and ICs) is the preferred alternative. This alternative is recommended because it achieves substantial risk reduction through RTD of waste sites; treats the highest uranium concentration location in the vadose zone and PRZ for groundwater protection; treats principal threat wastes; and provides the safe management of residual contamination through ICs. Table 5 lists all of the waste sites in the 300-FF-1 and 300-FF-2 OUs and how each would be specifically addressed under the preferred alternative. The preferred alternative may change in response to comments or new information.

Alternative 3a performs equally as well as Alternative 3, and better than Alternatives 2, 4, and 5, to permanently reduce TMV through treatment of the highest contaminant mass of uranium in the deep vadose zone and PRZ and in short-term effectiveness, including time to achieve RAOs (estimated time to cleanup is 22 to 28 years). Alternative 3a performs best in implementability. Alternative 3a performs equally as well as Alternatives 2, 3, and 4 with respect to long-term effectiveness and permanence.

DOE believes that the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. DOE expects the preferred alternative to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of HHE, (2) comply with ARARs (or justify a waiver), (3) be cost effective, (4) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element.

Selection of Alternative 3a as the final remedy would result in DOE and EPA issuing a ROD for the 300-FF-2 OU and 300-FF-5 OU and a ROD amendment for the 300-FF-1 OU.

The preferred alternative could be modified or another alternative selected through consideration of state acceptance and public comment on this Proposed Plan. After public comment, the EPA, in coordination with DOE, will then prepare a CERCLA ROD. This ROD will identify the selected remedy. A responsiveness summary containing agency responses to comments received during the public comment period will be made available with issuance of the ROD.

Table 5. Waste Sites Included in the Preferred Alternative

Technology/Approach	Waste Site
No additional action (waste sites that do not pose an unacceptable risk and do not require additional action): 38 waste sites	300 VTS, 300-1, 300-10, 300-109, 300-110, 300-18, 300-253, 300-256, 300-259, 300-260, 300-262, 300-275, 300-29, 300-33, 300-41, 300-45, 300-53, 300-8, 303-M SA, 303-M UOF, 311 MT1, 311 MT2, 313 MT, 331 LSLDF, 333 ESHWSA, 600-22, 600-243, 600-259, 600-46, 600-47, 618-13, 618-5, 618-7, 618-8, 618-9, UPR-300-17, UPR-300-41, UPR-300-46
RTD to industrial cleanup levels: 74 waste sites	300 RLWS, 300 RRLWS, 300-11, 300-121, 300-123, 300-15, 300-16, 300-175, 300-2, 300-214, 300-218, 300-219, 300-22, 300-224, 300-24, 300-249, 300-251, 300-255, 300-257, 300-258, 300-263, 300-265, 300-268, 300-269, 300-270, 300-273, 300-274, 300-276, 300-277, 300-279, 300-28, 300-280, 300-281, 300-283, 300-284, 300-286, 300-289, 300-291, 300-293, 300-294, 300-296, 300-32, 300-34, 300-4, 300-40, 300-43, 300-46, 300-48, 300-5, 300-6, 300-7, 300-80, 300-9, 313 ESSP, 316-3[a], 331 LSLT1, 331 LSLT2, 333 WSTF, 340 COMPLEX, 3712 USSA, 618-11, UPR-300-1, UPR-300-10, UPR-300-11, UPR-300-12, UPR-300-2, UPR-300-38, UPR-300-39, UPR-300-4, UPR-300-40, UPR-300-42, UPR-300-45, UPR-300-48 UPR-300-5
RTD to residential cleanup levels: 12 waste sites	300-287, 300-288, 300-290, 316-4, 400 PPSS, 400-37, 400-38, 600-290, 600-367, 600-63, 618-10, UPR-600-22,
Enhanced attenuation: 7 waste sites	316-1[b,c], 316-2[c], 316-3[a], 316-5[c], 618-1, 618-2, 618-3
Total waste sites: 130[a]	

a. Waste site 316-3 is identified for RTD and is also identified for enhanced attenuation for deep uranium contamination, if present.

b. Waste site 316-1 did not exceed preliminary remediation goals for protection of groundwater, but is being considered as a potential uranium source of groundwater contamination because of the large waste disposal inventory and the proximity of the waste site to higher groundwater concentrations.

c. Waste site included in the 300-FF-1 Operable Unit.

ESSP = East Side Storage Pad
ESHWSA = East Side Hazardous Waste Storage Area
LSLDF = Life Sciences Laboratory Drain Field
LSLT = Life Sciences Laboratory Trench
MT = Methanol Tank
PPSS = Process Pond and Sewer System
RLWS = Radioactive Liquid Waste Sewer
RRLWS = Retired Radioactive Liquid Waste Sewer
RTD = removal, treatment, and/or disposal
SA = Storage Area
UOF = Uranium Oxide Facility
UPR = unplanned release
USSA = Uranium Scrap Storage Area
VTS = Vitrification Test Site
WSTF = West Side Test Facility

Community Participation

Public input is a key element in DOE's decision-making process. The Tribal Nations and the public are encouraged to read and provide comments on any of the alternatives presented in this Proposed Plan, including the preferred alternative. The Administrative Record for this proposed remedial action decision is available for review at the repository locations listed to the right.

The comment period for this Proposed Plan extends from July 15, 2013, through August 14, 2013. Comments on the preferred alternative, other alternatives, or any element of this Proposed Plan or support information will be accepted through August 14, 2013. Send comments to:

Mail: Kim Ballinger
U.S. Department of Energy
Richland Operations Office
P.O. Box 550, A7-75
Richland, WA 99352
Email: 300AreaPP@RL.gov

For questions directed to EPA, please contact:

Mail: Larry Gadbois
EPA Region 10, Hanford Project Office
309 Bradley Blvd, Suite 115
Richland, WA 99352
Email: Gadbois.Larry@EPA.gov

To request a meeting in your area, please contact Kim Ballinger (509-376-6332) no later than August 1, 2013. After the public comment period, DOE and EPA will consider the comments regarding this Proposed Plan and the information gathered during the comment period.

Hanford Public Information Repository Locations

Administrative Record and Public Information Repository:
2440 Stevens Center Place
Room 1101, Richland, WA
Phone: (509) 376-2530
Website: http://www2.hanford.gov/arpir/

Portland
Portland State University
Branford P. Millar Library
1875 SW Park Avenue, Portland, OR
Phone: (503) 725-4542
Map: http://www.pdx.edu/map.html

Seattle
University of Washington
Suzallo Library, Government Publications Department
P.O. Box 352900, Seattle, WA 98195
Phone: (206) 543-5597
Map: http://tinyurl.com/m8ebj

Richland
Washington State University, Tri-Cities
Consolidated Information Center
Room 101-L, 2770 University Drive
Richland, WA
Phone: (509) 375-3308
Map: http://reading-room.labworks.org/Directions.aspx

Spokane
Gonzaga University Foley Center Library
East 502 Boone Ave., Spokane, WA 99258
Phone: (509) 313-6110
Map: http://tinyurl.com/2c6bpm

Table A-1. Preliminary Remediation Goals for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[d]	PRGs[a,b] Based on the Residential Scenario for Areas Outside Both the 300 Area Industrial Complex and the 618-11 Burial Ground		PRGs[b,c] for Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]
Radionuclides (pCi/g)					
Americium-241	--	32	--[g]	210	--[g]
Cesium-137	1.1	4.4	--[g]	18	--[g]
Cobalt-60	0.0084	1.4	--[g]	5.2	--[g]
Europium-152	--	3.3	--[g]	12	--[g]
Europium-154	0.033	3.0	--[g]	11	--[g]
Europium-155	0.054	125	--[g]	518	--[g]
Iodine-129	--	0.076	12.8	1,940	37.1
Plutonium-238	0.0038	39	--[g]	155	--[g]
Plutonium-239/240	0.025	35	--[g]	245	--[g]
Plutonium-241	--	854	--[g]	12,900	--[g]
Technetium-99	--	1.5	272	166,000	420
Total beta radiostrontium (Strontium-90)	0.18	2.3	227,000	1,970	--[g]
Tritium	--	459	9,180	1,980	12,200
Uranium-233/234	1.1	27.2	--[h]	167	--[h]
Uranium-235	0.11	2.7	--[h]	16	--[h]
Uranium-238	1.1	26.2	--[h]	167	--[h]
Total uranium isotopes (summed)	--	56.1	--[h]	350	--[h]
Chemicals (mg/kg)					
Antimony	0.13	32	252	1,400	760
Arsenic	6.5	20[i]	20[i]	20[i]	--[g]
Barium	132	16,000	--[g]	700,000	--[g]
Beryllium	1.5	160	--[g]	7,000	--[g]
Cadmium	0.56	80	176	3,500	--[g]
Chromium (total)	18.5	120,000	--[g]	>1,000,000	--[g]
Chromium (hexavalent)	--	2.1	2.0[j]	10,500	2.0[j]
Cobalt	15.7	24	--[g]	1,050	--[g]
Copper	22	3,200	3,400	140,000	--[g]
Lead	10.2	250	1,480	1,000	--[g]

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		Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]
Lithium	13.3	160	--[g]	7,000	--[g]
Manganese	512	11,200	--[g]	490,000	--[g]
Mercury	0.013	24	8.5	1,050	--[g]
Nickel	19.1	1,600	--[g]	70,000	--[g]
Selenium	0.78	400	302	17,500	912
Silver	0.17	400	--[g]	17,500	--[g]
Strontium	--	48,000	--[g]	>1,000,000	--[g]
Thallium	0.19	--	--[g]	--	--[g]
Tin	--	48,000	--[g]	>1,000,000	--[g]
Uranium	3.2	81	102	505	157
Vanadium	85.1	400	--[g]	17,500	--[g]
Zinc	68	24,000	64,100	>1,000,000	--[g]
Asbestos	--	--[k]	--[k]	--[k]	--[k]
Cyanide	--	48	636	42	1,960
Fluoride	2.8	4,800	--[g]	210,000	--[g]
Nitrate	52	568,000	13,600	>1,000,000	21,000
Aroclor 1016	--	5.6	--[g]	245	--[g]
Aroclor 1221	--	0.50	0.017	66	0.026
Aroclor 1232	--	0.50	0.017	66	0.026
Aroclor 1242	--	0.50	0.14	66	--[g]
Aroclor 1248	--	0.50	0.13	66	--[g]
Aroclor 1254	--	0.50	--[g]	66	--[g]
Aroclor 1260	--	0.50	--[g]	66	--[g]
1,1,1-Trichloroethane	--	3,660	361	8,000	686
1,2-Dichloroethene (total)	--	720	55	31,500	89
Methyl ethyl ketone (2-butanone)	--	28,400	1,670	62,200	2,590
Methyl isobutyl ketone (hexone) (4-methyl-2-pentanone)	--	6,400	285	28,700	445
Benzene	--	0.57	0.82	5.7	1.4

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cis-1,2-Dichloroethylene	--	160	11	7,000	18
Carbon tetrachloride	--	0.61	0.44	6.1	0.86
Chloroform	--	0.24	1.3	2.4	2.1
Ethyl acetate	--	72,000	--	>1,000,000	--
Ethylene glycol	--	160,000	5,030	>1,000,000	7,770
Hexachlorobutadiene	--	13	--[g]	1,680	--[g]
Hexachloroethane	--	2.5	23	25	72
Tetrachloroethene	--	20	2.4	82	6.0
Toluene	--	4,770	1,150	10,400	2,190
Trichloroethene	--	1.1	1.3	3.5	2.4
Vinyl chloride	--	0.53	0.013	5.2	0.021
Xylenes (total)	--	103	4,700	227	11,090
Benzo(a)pyrene	--	0.14	--[g]	18	--[g]
Chrysene	--	14	--[g]	1,800	--[g]
Phenanthrene	--	--	--	--	--
Tributyl phosphate	--	111	217	14,600	658
Normal paraffin hydrocarbon (kerosene)	--	2,000	2,000	2,000	2,000
Total petroleum hydrocarbons- diesel	--	2,000	2,000	2,000	2,000
Total petroleum hydrocarbons- motor oil	--	2,000	2,000	2,000	2,000

Note: The contaminants provided in this table are consistent with the contaminants of potential concern identified in the *300 Area Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (DOE/RL-2009-30). The soil COCs (Table 1 in this Proposed Plan) represent the primary risk-driver contaminants for the majority of the waste sites but are not comprehensive for all sites such as the 618-10 and 618-11 Burial Grounds. For these waste sites, the additional COCs will be identified in the remedial design report/remedial action work plan.

a. Vadose zone PRGs are based on the residential exposure scenario represented using the State's "*Model Toxics Control Act*—Cleanup" (WAC 173-340) unrestricted use for chemicals and a residential exposure scenario for radionuclides.

b. Vadose zone PRGs for the protection of groundwater and surface water were calculated based on site-specific data and specific parameters using the STOMP code with a one-dimensional model for all contaminants except uranium. For uranium, the STOMP code was used with a two-dimensional model that includes the effects of uranium's more complex sorption behavior.

For highly mobile contaminants (K_d <2), the model assumes the entire vadose zone from ground surface to groundwater is contaminated. For less mobile contaminants ($K_d \geq 2$), the model assumes the top 70 percent is contaminated and the bottom 30 percent is not contaminated. For the 300 Area Industrial Complex and 618-11 Burial Ground, a groundwater recharge rate of 25 mm/year was used for the long term, representing a permanently disturbed soil with cheatgrass vegetative cover. For the residential scenario, a groundwater recharge rate of approximately 72 mm/year was used, representing an irrigated condition. Model details are contained in the 300 Area RI/FS report (Section 5.7 and Table 5.4 of DOE/RL-2010-99).

Table A-1. Preliminary Remediation Goals for Protection of Human Health and for Groundwater and Surface Water Protection

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		Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (< = 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]

c. Vadose zone PRGs are based on the industrial scenario represented using Washington State's MTCA (WAC 173-340, "Model Toxics Control Act—Cleanup") industrial scenario for chemicals and an industrial worker exposure scenario for radionuclides.

d. Hanford Site background values for nonradionuclides: DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*; Hanford Site background values for radionuclides: DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

e. Vadose zone PRGs for the protection of groundwater and surface water (industrial condition) are provided in the 300 Area RI/FS report (Table 8-4 of DOE/RL-2010-99) and the 300 Area RI/FS report addendum (Table 2-2 of DOE/RL-2010-99-ADD1).

f. Vadose zone PRGs for the protection of groundwater and surface water (irrigated condition) are provided in the 300 Area RI/FS report addendum (Table 2-3 of DOE/RL-2010-99-ADD1).

g. Based on this model, for some contaminants no PRGs are calculated either because the contaminant is not expected to reach the groundwater, or the soil concentration necessary to be a groundwater risk is physically improbable or impossible with the available porosity in the soil.

h. A PRG is calculated for total uranium but not for isotopic uranium because a drinking water standard is not available for the different uranium isotopes. When total uranium analytical results (µg/kg) are available, exposure point concentrations are compared to the total uranium PRG. When only isotopic uranium results (pCi/g) are available, uranium is addressed by converting the isotopic uranium from activity-based (pCi/g) to mass-based (µg/kg) and summing to provide a mass-based total uranium exposure point concentration.

i. Outside both the 300 Area Industrial Complex and 618-11 Burial Ground, the PRG for arsenic is compared to the WAC 173-340-900, Table 740-1, Method A, soil cleanup level for unrestricted land use. Inside the 300 Area Industrial Complex and 618-11 Burial Ground, the PRG for arsenic is compared to the WAC 173-340-900, Table 745-1, Method A, soil cleanup levels for industrial properties.

j. The PRG for hexavalent chromium is set to the interim action cleanup level of 2.0 mg/kg (DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*).

k. Cleanup levels for asbestos have not been established due to difficulty in measurement. If asbestos contamination from material containing less than 1 percent asbestos is discovered, DOE will consult with EPA to determine whether excavation and removal of the asbestos or other actions are necessary to protect human health and the environment. Such actions may include, but are not limited to, addressing the asbestos in accordance with provisions in DOE/RL-2010-22, *Action Memorandum for General Hanford Site Decommissioning Activities*, for cleanup of miscellaneous debris and/or evaluating asbestos contamination for applicability under 40 CFR 61.154 "National Emission Standards for Hazardous Air Pollutants," "Standard for Active Waste Disposal Sites," or 40 CFR 61.155, "Standard for Operations that Convert Asbestos-Containing Waste Material into Nonasbestos (Asbestos-Free) Material."

—	= not available	K_d	= distribution coefficient
bgs	= below ground surface	MTCA	= *Model Toxics Control Act*
CFR	= *Code of Federal Regulations*	PRG	= preliminary remediation goal
COC	= contaminant of concern	STOMP	= Subsurface Transport Over Multiple Phases
DOE	= U.S. Department of Energy	WAC	= *Washington Administrative Code*
EPA	= U.S. Environmental Protection Agency		

Table A-2. Preliminary Remediation Goals for Groundwater

Contaminant	Units	Drinking Water Standard	Aquatic Standard	Proposed Remediation Goal
Uranium	µg/L	30	--[a]	30
Tritium	pCi/L	20,000	--[a]	20,000
Nitrate (as NO_3)	µg/L	45,000	--[a]	45,000
Trichloroethene	µg/L	5	--[a]	4[b]
cis-1,2-Dichloroethene	µg/L	70	--[a]	16[b]
Gross alpha	pCi/L	15	--[a]	15

a. A Washington State water quality standard (WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington") or *Clean Water Act of 1972* ambient water quality criterion (40 CFR 131, "Water Quality Standards") is not published for the listed contaminant.

b. The PRGs for trichloroethene and cis-1,2-dichloroethene are based on values in the Integrated Risk Information System database maintained by EPA for use in EPA's risk assessment process (Section 2.2 of the 300 Area RI/FS report addendum [DOE/RL-2010-99-ADD1]).

— = not available

CFR = *Code of Federal Regulations*

EPA = U.S. Environmental Protection Agency

PRG = preliminary remediation goal

WAC = *Washington Administrative Code*

Acronym List

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CLUP	Comprehensive Land-Use Plan
COC	contaminant of concern
COPC	contaminant of potential concern
CRC	Columbia River Component
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
DWS	drinking water standard
Ecology	Washington State Department of Ecology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ERDF	Environmental Restoration Disposal Facility
FFTF	Fast Flux Test Facility
FS	feasibility study
HAMMER	Volpentest Hazardous Materials Management and Emergency Response Training and Education Center
HCP EIS	Hanford Comprehensive Land-Use Plan Environmental Impact Statement
HHE	human health and the environment
HHRA	human health risk assessment
HRNM	Hanford Reach National Monument
IC	institutional control
LFI	limited field investigation
MCL	maximum contaminant limit
MNA	monitored natural attenuation

MTCA	*Model Toxics Control Act*
NCP	National Contingency Plan
NEPA	*National Environmental Policy Act of 1969*
NPL	National Priorities List
O&M	operation and maintenance
OU	operable unit
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PRZ	periodically rewetted zone
RAO	remedial action objective
RCBRA	River Corridor Baseline Risk Assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
RI	remedial investigation
ROD	Record of Decision
RTD	removal, treatment, and disposal
TCE	trichloroethene
TMV	toxicity, mobility, or volume
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
TRU	transuranic
TSD	treatment, storage, and/or disposal
UPR	unplanned release
VOC	volatile organic compound

Glossary

Administrative Record: The collection of information, including reports, public comments, and correspondence, that contains the documents that form the basis for the selection of a response action. A list of locations where the Administrative Record is available appears in the "Community Participation" section of this Proposed Plan.

Ambient water quality criteria: As defined by EPA, the maximum allowable concentration of a chemical in surface water for the protection of human health.

Apatite: A calcium-phosphate mineral ($Ca_5[PO_4]_3[OH]$).

Applicable or relevant and appropriate requirements (ARARs): "Applicable" requirements are those cleanup standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, response action, location, or other circumstance at a CERCLA site. "Relevant and appropriate" requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law which, while not "applicable" at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited.

Aquitard: A zone within an aquifer which does not yield water easily.

Attenuation rate: The rate at which concentrations of a contaminant decrease due to natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption.

Autunite: A hydrated calcium uranyl phosphate mineral [$Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$].

Baseline risk assessment: An assessment that characterizes the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain. The results of the baseline risk assessment help establish acceptable exposure levels for use in developing remedial alternatives in the feasibility study.

Characterization: Identification of the characteristics of a site through review of existing site information and sampling and analysis of environmental media and materials, to determine the nature and extent of contamination.

***Code of Federal Regulations* (CFR):** The codification of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the federal government. It is divided into 50 titles that represent broad areas subject to federal regulation. Each volume of the CFR is updated once each calendar year and is issued on a quarterly basis.

***Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA):** A federal law also known as the Superfund Act.

Confining layer: A low-permeability layer beneath an unconfined aquifer that prevents or significantly restricts groundwater flow through it.

Contaminant of concern (COC): A subset of the contaminants of potential concern that are identified in the remedial investigation/feasibility study as needing to be addressed by a response action.

Contaminant of potential concern (COPC): A contaminant identified as a potential threat to human health or the environment and evaluated further in the baseline risk assessment.

Crib: A near-surface underground structure designed to receive liquid waste that can percolate directly into the soil.

Debris: Building or construction material that has been demolished.

Drinking water standard (DWS): The maximum allowable concentration of a chemical or radionuclide constituent in drinking water that is protective of human health. The DWSs, described in 40 CFR 141 ("National Primary Drinking Water Regulations"), are also known as maximum contaminant levels.

Environmental Restoration Disposal Facility (ERDF): The Hanford Site CERCLA-approved disposal facility for most hazardous (radioactive and nonradioactive) waste and contaminated environmental media generated under a CERCLA response action that meet the waste disposal acceptance criteria.

Excess lifetime cancer risk (ELCR): A numerical estimate of the incremental probability of an individual developing cancer over a lifetime as a result of a reasonable maximum site related exposure to a potential carcinogen.

Exposure point concentration (EPC): A conservative estimate of the average chemical concentration in an exposure medium.

Feasibility study (FS): A study undertaken by the lead regulatory agency to develop and evaluate options for remedial action. The FS emphasizes data analysis and is generally performed concurrently and in an interactive fashion with the remedial investigation, using data gathered during the remedial investigation. The remedial investigation data are used to define the objectives of the response action, to develop remedial action alternatives, and to undertake an initial screening and detailed analysis of the alternatives. The term also refers to a report that describes the results of the study.

Groundwater: Water in a saturated zone or geologic stratum beneath the land surface or beneath a surface water body.

Hazard index: An indicator of potential noncarcinogenic consequences in humans (e.g., damage to organs) caused by exposure to contaminants. The hazard index is a sum of contributions from multiple contaminants. The threshold value for toxic effects is a hazard index of one or more.

Hydraulic gradient: The slope of the water table along a groundwater flow path.

Institutional control (IC): Nonengineered instrument such as administrative or legal measures to protect human health and the environment from exposure to contamination. ICs are maintained until requirements are met for safe, unrestricted land use.

Limited field investigation (LFI): The collection of limited additional site data that are sufficient to support a decision on conducting an ecological risk assessment or interim remedial measure.

Maximum contaminant level (MCL): The maximum concentration of a contaminant allowed in water delivered to public drinking water systems.

***Model Toxics Control Act* (MTCA):** MTCA (RCW 70.105D, "Hazardous Waste Cleanup--Model Toxics Control Act") provides state cleanup regulations for protection of human health and the environment. The standards and requirements established to implement MTCA are published in WAC 173-340 ("Model Toxics Control Act—Cleanup").

Monitored natural attenuation (MNA): A decrease in the concentration of a contaminant because of natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption. Monitoring is conducted to determine if the attenuation is occurring as predicted or if additional cleanup activities are warranted.

***National Environmental Policy Act of 1969* (NEPA):** A U.S. environmental law that requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Federal agencies conducting CERCLA actions may rely on the CERCLA process for environmental reviews that are functionally equivalent and are not required to engage in a separate NEPA analysis such as preparation of environmental assessments and environmental impact statements (40 CFR 1500, "Purpose, Policy, and Mandate"; "National Environmental Policy Act Policy Statement" [O'Leary, 1994]).

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The NCP is required by CERCLA Section 105, as amended by the *Superfund Amendments and Reauthorization Act of 1986*. The purpose of the NCP is to provide the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

National Priorities List (NPL): The list, compiled by EPA pursuant to CERCLA Section 105, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

Nature and extent of contamination: Characteristics of contamination at a site, including concentrations and degree of migration in the environment.

Operable unit (OU): A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site can be divided into a number of OUs, depending on the complexity of the problems associated with the site. OUs may address geographical portions of a site, specific-site problems, or initial phases of an action; or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site.

Operations and maintenance (O&M): Those measures required to maintain the effectiveness of response actions.

Periodically rewetted zone (PRZ): The interval in the deep vadose zone where the groundwater table seasonally fluctuates between its highest level and its lowest level in response to changes in the Columbia River.

Picocurie (pCi): A unit of radioactivity equivalent to $1.0 \times 10E^{-12}$ curies or 0.037 disintegrations per second.

Preferred alternative: The recommended remedial action, following an evaluation of all alternatives, that meets CERCLA threshold criteria (protection of human health and the environment, and compliance with ARARs) and performs best with respect to the CERCLA balancing criteria.

Preliminary remediation goal (PRG): A risk-based value for specific contaminant and exposure pathways that establish acceptable exposure levels protective of human health and the environment. PRGs are established during the feasibility study based on scientific information and are used as a target for remedial cleanup goals. Alternatives are developed and evaluated based on how well they meet the goals. Final remediation goals are determined when the remedy is selected in the record of decision and are used during the remediation of a site.

Present value (discounted): Represents the dollars that would need to be set aside today, at the defined interest rate, to ensure that funds would be available in the future as they are needed to perform the remedial alternative.

Proposed Plan: A plan that briefly describes the remedial alternatives analyzed, proposes a preferred remedial action alternative and summarizes the information relied upon to select the preferred alternative. The Proposed Plan provides the public with an opportunity to comment on the preferred alternative, as well as the other alternatives under consideration.

Radionuclide: An unstable atom that emits excess energy (decays) in the form of radioactivity (rays or particles). Depending on the type and amount of decay, prolonged exposure may be harmful.

Record of Decision (ROD): A legally binding public document that identifies the selected remedy for an operable unit and the rationale behind the selection.

Remedial action: Actions consistent with permanent remedy taken instead of, or in addition to, removal actions in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so they do not migrate to cause substantial danger to present or future public health or welfare or the environment.

Remedial action objective (RAO): A medium-specific (e.g., soil) or operable unit-specific goal for protecting human health and the environment that specifies the contaminant(s) of concern, the exposure route(s), and receptor(s).

Remedial alternative: General or specific actions that are developed and evaluated so relevant information concerning the remedial action options can be presented to a decision maker and an appropriate remedy selected.

Remedial investigation (RI): A process undertaken by the lead regulatory agency to determine the nature and extent of the problem presented by the release. The RI emphasizes data collection and site characterization, and it is generally performed concurrently and in an interactive fashion with the feasibility study. The RI includes sampling and monitoring, as necessary, and includes the gathering of sufficient information to determine the necessity for remedial action and to support the evaluation of remedial alternatives.

Removal, treatment, and disposal (RTD): A cleanup method by which soil and debris are excavated in such a way to remove contaminated media so the residual at a waste site meets the approved cleanup levels or concentration for direct exposure and groundwater protection. Excavated material is treated (as necessary) and sent to an onsite or offsite engineered facility for disposal.

Responsiveness summary: This summary is made available with the ROD and contains the public comments received on the proposed plan and the Tri-Parties' responses.

Transuranic (TRU): Waste material containing any alpha-emitting radionuclide with an atomic number greater than 92, a half-life longer than 20 years, and a concentration greater than 100 nCi/g at the time of assay.

Tri-Party Agreement: The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order*, or Tri-Party Agreement, on May 15, 1989. The Tri-Party Agreement (Ecology et al., 1989), as updated and modified through formal change control, is an agreement for achieving compliance with the CERCLA remedial action provisions and with RCRA treatment, storage, and disposal unit regulations and corrective action provisions. More specifically, the Tri-Party Agreement (1) defines and prioritizes CERCLA and RCRA cleanup commitments, (2) establishes responsibilities, (3) provides a basis for budgeting, and (4) reflects a concerted goal of achieving full regulatory compliance and remediation, with enforceable milestones.

Tri-Parties: Three agencies composed of the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology).

Unplanned release (UPR): The dispersal of chemical and radioactive contaminants through material transfers, airborne disseminations, or plant or animal fecal material.

Uranium sequestration: A cleanup method where polyphosphate chemicals are added to the soil and/or groundwater to permanently bind up (or sequester) contaminant uranium, thus preventing it from becoming mobile.

Vadose zone: The unsaturated soil column between the land surface and the groundwater.

Waste sites: Contaminated or potentially contaminated sites from past operations. Contamination may be contained in environmental media (e.g., soil, groundwater) or in manmade structures or solid waste (e.g., debris).

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